DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

PUBLICATIONS
OF THE
BUREAU OF STANDARDS

1901-1925

CIRCULAR OF THE BUREAU OF STANDARDS, No. 24

DEPARTMENT OF COMMERCE

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PUBLICATIONS

OF THE

BUREAU OF STANDARDS

[7th EDITION—FINAL]

Complete from establishment of Bureau (1901) to June 30, 1925

[For later publications see Supplementary List of Publications (Annual) from which the continuing volume (Circular 24a) will be made up when the number of later publications warrants]

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FOREWORD

In addition to the tests and comparisons made by the Bureau of Standards, its work includes such researches as are involved in the establishment and maintenance of the various standards and units of measurement, the development of measuring instruments and methods of measurement, the determination of physical constants, and the properties of materials. The results of these investigations are published in pamphlet form, and in the following pages is given a descriptive list of these papers. The papers are issued in eight separate series designated as follows: S = Scientific Papers; T = Technologic Papers; C = Circulars; H = Handbooks; R = Simplified Practice Recommendations; L = Limitation of Variety Recommendations; BH = Building and Housing, and M = Miscellaneous Publications. They cover a wide range of subjects in the field of physical measurements and the properties of materials, and are issued for general distribution to the scientific, technical, and industrial interests concerned with the subjects treated. Series S and T may be subscribed for in advance by volume, addressing the Superintendent of Documents.

The official distribution of a limited free edition includes single copies to the technical press, designated Government depository libraries, those collaborating with the bureau in its investigations, organizations exchanging like courtesies with the bureau, and certain specialists concerned with the subjects treated. *Others, however, may purchase them from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices stated.* When applying to the Bureau of Standards for any of these publications, merely state the symbol and number preceding the title; when ordering from the Superintendent of Documents, give symbol and number of publication and name of bureau.

This general circular will be revised from time to time. A supplement to this circular brings the list up to date and contains a list of bureau publications not obtainable and which may be consulted at some designated Government depository library, and the publications that have been delivered since this circular was issued.

The supplement contains an index which, with the index to the main circular, affords a complete topical reference to the published work of the Bureau of Standards.

PUBLICATIONS OF THE BUREAU OF STANDARDS

CONTENTS

	Page
Foreword	2
General information	3
Scientific Papers	5
Technologic Papers	101
Circulars	163
Handbooks	205
Simplified Practice Recommendations	207
Limitation of Variety Recommendations	215
Building and Housing	217
Miscellaneous Publications	219
Index	231

GENERAL INFORMATION

1. ANNOUNCEMENTS OF NEW PUBLICATIONS

In addition to Circular No. 24 and its supplement, the bureau publishes announcement cards giving titles and prices of new publications. These cards will be regularly sent to any interested persons, upon request.

2. TECHNICAL NEWS BULLETIN

The TECHNICAL NEWS BULLETIN of the Bureau of Standards was issued in mimeographed form and sent to a limited mailing list from June, 1919, to April, 1925. It was then decided to publish the BULLETIN in printed form in order to care for the increased demand. The first number to appear in that form (Bulletin No. 97) was issued in May, 1925. The BULLETIN can be obtained on a subscription basis from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 25 cents per year. It is issued once a month and contains short items describing progress of work in the laboratories, notices of important meetings which have taken place at the bureau, and a list of publications released during the preceding month.

3. DISTRIBUTION

A small bureau edition is available for an *initial* official distribution to libraries, technical journals, and experts who cooperate in the work or who are directly concerned with it. Others may purchase the publications from the Superintendent of Documents as described below at the nominal prices shown.

4. ORDERING

Any of the publications herein, with the exception of those listed under "Publications Not Available" in the accompanying supplement may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price indicated. Purchase orders with remittance *should be sent to the Superintendent of Documents.* (Do not send any such orders or remittances to the Bureau of Standards.) Remittance should be made in the form of money order, check, or cash, and is at sender's risk.

Order by serial initial letter and number combined (for example, "Bureau of Standards publication T281"). If initial and number are correctly given, the title is not needed.

All publications are sent out by the Superintendent of Documents, as provided by law, and usually reach destination within a week or two.

5. BOUND VOLUMES

In addition to the separate papers, both the Scientific and Technologic series are also issued in bound form of about 750 pages for each volume, consecutively paged, including title-page and index. Subscription for either series may be placed in advance with the Superintendent of Documents, Government Printing Office, Washington, D. C., to receive the separates as issued at $1.25 per volume (unbound), and $2 for each volume bound in cloth. See price list below.

The Scientific Papers may be obtained in bound form from Volume 1 to 19. (Previous to Volume 15 they were called Reprints and in the bound form were known as the "Bulletin.") Plan (*d*) is especially recommended.

The Technologic Papers in the bound form begin with Volume 16, Technologic Paper No. 203. Previous to this they had only been issued as separates. Plan (*g*) is especially recommended.

6. PRICE LIST AND SUBSCRIPTION BASIS

	Per volume
(*a*) Bulletins of the Bureau of Standards, vols. 1–14, inclusive; 1904–1914 (cloth)	$2.00
(*b*) Series (*a*) continued—Scientific Papers of the Bureau of Standards, vol. 15 on (cloth)	2.00
(*c*) Unbound separates, preprints of (*b*), sent as issued	1.25
(*d*) Combination of (*c*) and (*b*)	3.25
(*e*) Technologic Papers of the Bureau of Standards, beginning with vol. 16 (cloth)	2.00
(*f*) Unbound separates of Technologic Papers sent as issued	1.25
(*g*) Combination of (*f*) and (*e*)	3.25

SCIENTIFIC PAPERS

[For publications in the following list that are out of print or procurable only from Superintendent of Documents, Government Printing Office, Washington, D. C., see the supplement to this Circular.]

S1. Recomparison of the United States Prototype Meter . . . . . *L. A. Fischer*

An account of a comparison made between the United States Meter No. 27 and the standards of the International Bureau of Weights and Measures, giving the observations in detail, and a description of the method of comparison and the apparatus. (June 15, 1904.) 15 pp. Price, 5 cents.

S2. A Study of the Silver Voltameter . . . . . *K. E. Guthe*

A description of the various forms of silver voltameters that have been used for measuring the unit of electric current and a comparison of the results obtained by them, including especially the comparison of the filter-paper type with the porous-cup type. (Sept. 1, 1904.) 17 pp. [Superseded by S194, S195, S201, S220, S240, S271, S283, S285.]

S3. The So-called International Electrical Units . . *Frank A. Wolff*

A paper presented to the St. Louis International Congress on the redefinition of the fundamental units, with a historical review and an appendix on laws concerning electrical units adopted by this and foreign governments. (July 1, 1904.) 38 pp. (See also S102.) [Superseded by Circular No. 60.]

S4. The Spectra of Mixed Gases . . . . . *P. G. Nutting*

It is shown that in spectra of electrically conducting mixtures of gases, other things being equal, the spectrum of the gas of highest atomic weight will be brightest. (July 15, 1904.) 5 pp. Price, 5 cents.

S5. On Secondary Spectra and the Conditions under which they may be Produced . . . . . *P. G. Nutting*

A determination of what elements give two different spectra and the conditions of excitation necessary for the production of each. (July 15, 1904.) 11 pp. Price, 15 cents.

S6. Some New Rectifying Effects in Conducting Gases . . . . . *P. G. Nutting*

When electrodes differ in size, form, temperature, material, condition of surface, nature, and density of surrounding gas, the current tends to pass more easily in one direction than in the reverse, thus giving an excess of current in one direction. (July 15, 1904.) 6 pp. Price, 5 cents.

S7. On Fibers Resembling Fused Quartz in Their Elastic Properties . . . . . *K. E. Guthe*

Owing to the difficulty of obtaining fibers of fused quartz of sufficient strength to carry a load of 500 g and at the same time to have a small elastic fatigue, experiments were made to find a substitute. It was found that fibers of steatite could be easily drawn and possessed the desired properties. (Sept. 1, 1904.) 7 pp. Price, 10 cents.

S8. On the Temperature of the Arc . . . . . .
. . . . . *C. W. Waidner and G. K. Burgess*

Estimation of the black-body temperature of positive crater with Le Chatelier, Wanner, and Holborn-Kurlbaum optical pyrometers; variation of temperature with current; review of previous work. Measurements based on Wien-Planck equation for monochromatic radiation. (Sept. 1, 1904.) 16 pp. Price, 5 cents.

S9. The Absolute Measurement of Inductance . . . . . .
. . . . . *E. B. Rosa and F. W. Grover*

The inductances of some standards are measured by the impedance method (using alternating current) in terms of resistance and the frequency of the current. The wave form of the current used is accurately determined and analyzed, and a correction applied for the harmonics present. (Oct. 15, 1904.) 28 pp. Price, 10 cents.

S10. The Absolute Measurement of Capacity . . . . . .
. . . . . *E. B. Rosa and F. W. Grover*

The capacity of standard mica condensers is measured by the Maxwell bridge, in terms of resistance and time. Sources of error are carefully investigated, and results of measurements on a number of condensers given. (Nov. 1, 1904.) 35 pp. Price, 15 cents.

S11. Optical Pyrometry . . . . . *C. W. Waidner and G. K. Burgess*

Review of the laws of radiation and their application to the measurement of high temperatures. Experimental investigation of various types of optical and radiation pyrometers as to methods of calibration, sources of error, order of accuracy, and necessary precautions. Applications to the radiation from platinum and other substances. (Sept. 15, 1904.) 61 pp. Price, 10 cents.

S12. On the Theory of the Matthews and the Russell-Léonard Photometers for the Measurement of Mean Spherical and Mean Hemispherical Intensities . . . . . *Edward P. Hyde*

The accuracy of these instruments in measuring lamps with various simple polar distribution curves is investigated. The method is given for computing the best arrangement of any given number of mirrors to obtain relative values between lamps having different distribution curves. (Oct. 1, 1904.) 21 pp.

S13. The Testing of Clinical Thermometers . . . . . .
. . . . . *C. W. Waidner and L. A. Fischer*

Description of apparatus and methods used in the testing of clinical thermometers. Specifications governing tests. (Nov. 1, 1905.) 15 pp. Price, 15 cents.

S14. Measurement of Inductance by Anderson's Method, using Alternating Currents and a Vibration Galvanometer . . . . . *E. B. Rosa and F. W. Grover*

This method gives inductance in terms of capacity and resistance. The theory of the method is fully worked out and formulæ derived for the corrections depending on the residual capacities and inductances of the arms of the bridge. Results show that high accuracy is possible. A very convenient and reliable method for a wide range of inductances. (Aug. 15, 1905.) 44 pp. Price, 15 cents.

S15. Use of Serpentine in Standards of Inductance . . . .
. . . . . *E. B. Rosa and F. W. Grover*

Serpentine spools are shown to be unsuitable for standards of inductance, as the serpentine is slightly magnetic and its permeability variable. Hence the inductance of the coil depends to some extent on how much current is passing through the coil when it is in use. Marble is nonmagnetic and therefore better. Mahogany spools saturated with paraffin are quite satisfactory. (Aug. 15, 1905.) 12 pp. Price, 10 cents.

S16. The Silver Coulometer . . . . . *K. E. Guthe*

A critical comparison of different forms of silver coulometer (or voltameter) with an account of some new work with various types and a discussion of the values that have been obtained for the electrochemical equivalent of silver. [Superseded by S285.] (Sept. 1, 1905.) 16 pp.

S17. History of the Standard Weights and Measures of the United States . . . . . *L. A. Fischer*

A brief description of the standards of length and mass accepted at different periods by the United States Government. (June 30, 1905.) 17 pp. Price, 10 cents.

S18. Wattmeter Methods of Measuring Power Expended upon Condensers and Circuits of Low Power Factor . . . . . *Edward B. Rosa*

The power expended upon a condenser may be measured by a wattmeter, but owing to the small power factor of the current accurate measurements are difficult. Several new null methods are given which permit sensitive instruments to be used and accurate results obtained. (Sept. 1, 1905.) 15 pp. Price, 10 cents.

S19. The Relative Intensities of Metal and Gas Spectra from Electrically Conducting Gases . . . . *P. G. Nutting*

A study of the conditions which determine whether the spectrum of the electrodes shall be brighter or fainter than the spectrum of the surrounding gas. (Aug. 1, 1905.) 18 pp.

S20. The Use of White Walls in a Photometric Laboratory . . . . . *Edward P. Hyde*

If proper black velvet screens are employed on a photometer bench, the leakage of light into the photometer, due to the diffuse reflection from white walls, is shown to be so small as to be negligible. (July 15, 1905.) 4 pp. Price, 5 cents.

S21. Influence of Wave Form on the Rate of Integrating Induction Wattmeters . . . . . *E. B. Rosa, M. G. Lloyd, and C. E. Reid*

Experiments on integrating wattmeters show a variation in the rate with changes in the frequency and wave form of the current. (Aug. 15, 1905.) 14 pp. Price, 10 cents.

S22. Detector for Small Alternating Currents and Electrical Waves . . . . . *L. W. Austin*

An investigation of the rectifying effects obtained when using copper electrodes in a solution of copper sulphate. (Aug. 1, 1905.) 4 pp. Price, 5 cents.

S23. The Positive Charges Carried by the Canal Rays . . . . . *L. W. Austin*

An experimental demonstration of the positive charges carried by the canal rays. (Aug. 15, 1905.) 3 pp. Price, 5 cents.

S24. Radiation from Platinum at High Temperatures . . . . . *G. K. Burgess*

On a linear relation between the true temperature and the black-body temperature of a radiating substance. (Aug. 15, 1905.) 3 pp. Price, 5 cents.

S25. A Five-Thousand Volt Generator Set . . . . . *P. G. Nutting*

A description of a set of 10 small generators giving a direct current of 0.2 ampere at 5000 volts. (Sept. 15, 1905.) 3 pp. Price, 5 cents.

S26. Talbot's Law as Applied to the Rotating Sectored Disk . . . . . *Edward P. Hyde*

The apparent intensity of a source, before which a sectored disk is rotating rapidly, is found to be proportional to the total angular opening of the sectored disk for all angles between 288° and 10°. (Mar. 1, 1906.) 32 pp. Price, 15 cents.

S27. A New Determination of the Electromotive Force of Weston and Clark Standard Cells by an Absolute Electrodynamometer . . . . . *K. E. Guthe*

An account of the construction and determination of the constant of a Gray absolute electrodynamometer and work done with the same in determining the absolute value of the electromotive force of standard cells, assuming the international ohm. (Later determinations of values for electrical standards are given in C60. See also S171.) (Jan. 15, 1906.) 38 pp. Price, 5 cents.

S28. The Gray Absolute Electrodynamometer . . . *Edward B. Rosa*

A discussion of the theory of the instrument, showing the order of magnitude of certain possible errors and how the dimensions should be taken to conform to the conditions assumed in the formula for the dynamometer. (Jan. 30, 1906.) 16 pp. Price, 5 cents.

S29. Construction and Calculation of Absolute Standards of Inductance . . . . . *J. G. Coffin*

A description of two standards of self-inductance and the calculation of their inductance. Two formulas for the calculation of their self-inductances are derived, and several other formulas for the calculation of inductances are given. (Feb. 1, 1906.) 57 pp. Price, 10 cents.

S30. An Efficiency Meter for Electric Incandescent Lamps . . . . . *E. P. Hyde and H. B. Brooks*

By means of a variable resistance in series with the voltage circuit of a wattmeter and controlled by the position of the photometer screen the wattmeter is made to indicate watts per candle directly. (Mar. 15, 1906.) 16 pp. Price, 10 cents.

S31. Calculation of the Self-Inductance of Single-Layer Coils . . . . . *Edward B. Rosa*

Single layer cylindrical coils are the best form of absolute self-inductances to construct and measure, but the formulas used in their calculation all assume that the current flows in a continuous sheet over the cylindrical surface. In this paper formulas are derived and tables given for calculating two correction terms to be applied to the results obtained from the current sheet formulæ to give the true self-inductance of an actual coil. (Mar. 15, 1906.) 29 pp. Price, 10 cents.

S32. Heat Treatment of High-Temperature Mercurial Thermometers . . . . . *Hobert C. Dickinson*

Review of previous work. Results of annealing thermometers of different kinds of glass at various temperatures for long periods. Suggestions concerning the proper heat treatment of thermometers, electric annealing furnaces, and the pointing of thermometers to read true gas-scale temperatures. (Apr. 15, 1906.) 36 pp. Price, 10 cents.

S33. A New Potentiometer for the Measurement of Electromotive Force and Current . . . . . *H. B. Brooks*

Theory and design of a new instrument for accurate measurements. Consists of a potentiometer with one dial, on which the larger part of the quantity is read off, the remainder being shown by the deflection of a pivoted galvanometer. [Superseded by S172 and S173.] (Mar. 30, 1906.) 17 pp. Price, 10 cents.

S34. Spectrum Lines as Light Sources in Polariscopic Measurements.....*Frederick Bates*

A theoretical investigation of errors incidental to the use of a two-line source. An international standard source is advocated and a measurement made of the ratio of the rotation of quartz for this source and the sodium lines. (May 1, 1906.) 11 pp. Price, 10 cents.

S35. Polarimetric Sensibility and Accuracy.....*P. G. Nutting*

A theoretical investigation of analyzers and light sources for obtaining the highest possible sensibility and accuracy in polarimetry. (May 6, 1906.) 13 pp.

S36. On the Platinum Point Electrolytic Detector for Electrical Waves.....*L. W. Austin*

An experimental study of the platinum-point electrolytic detector, including the sensibility of the detector for electrical waves from a distance as well as from apparatus in the same laboratory. (Mar. 30, 1906.) 15 pp. Price, 5 cents.

S37. Influence of Frequency upon the Self-Inductance of Coils.....*J. G. Coffin*

A mathematical discussion of the variation of the self-inductance of a single layer coil with the frequency of the current. (Mar. 30, 1906.) 23 pp. Price, 10 cents.

S38. Experiments on the Heusler Magnetic Alloys.....
.....*K. E. Guthe and L. W. Austin*

Experimental study of seven samples of Heusler magnetic alloys, which are made from nonmagnetic metals. The magnetic properties of these samples are given in tables and curves. (Mar. 30, 1906.) 21 pp. Price, 10 cents.

S39. A Pocket Spectrophotometer.....*P. G. Nutting*

A description of a modified spectrophotometer on the plan of a pocket spectroscope. (July 15, 1906.) 3 pp. Price, 5 cents.

S40. Preliminary Measurements on Temperature and Selective Radiation of Incandescent Lamps..
.....*C. W. Waidner and G. K. Burgess*

Measurement of temperature and selective radiation of filaments of tantalum, tungsten, and carbon. On the melting point of tungsten. (Sept. 30, 1906.) 11 pp. Price, 5 cents.

S41. Revision of the Formulæ of Weinstein and Stefan for the Mutual Inductance of Coaxial Coils..
.....*Edward B. Rosa*

Weinstein's formula is accurate only for coils at distances large as compared with the cross section, and Stefan's only at near distances. Weinstein's is revised and corrected, and a new formula derived to replace Stefan's, the two agreeing closely and giving very accurate results. (Sept. 1, 1906.) 27 pp. Price, 5 cents.

S42. The Mutual Inductance of Two Circular Coaxial Coils of Rectangular Section.....
.....*E. B. Rosa and Louis Cohen*

Various formulas for calculating the mutual inductance of coaxial circles and coaxial circular coils of rectangular section are investigated, and some new formulas derived. The best formulas for particular cases are indicated; it is shown where some formulas fail, and numerous examples are given to illustrate the formulas. (Sept. 1, 1906.) 56 pp. Price, 10 cents.

S43. On the Determination of the Mean Horizontal Intensity of Incandescent Lamps by the Rotating Lamp Method . . . *E. P. Hyde and F. E. Cady*

A study of the errors incident to this method, due (1) to the distortion of the filament on rotation, and (2) to the inability of the eye to estimate accurately a badly flickering illumination. By the use of a single stationary mirror accurate measurements of mean horizontal candlepower can be made even with badly flickering lamps. (Sept. 1, 1906.) 23 pp. Price, 10 cents.

S44. Purity and Intensity of Monochromatic Light Sources . . . . . *P. G. Nutting*

A mathematical treatment of spectral impurity and center of luminosity, with the results of an investigation of available light sources. (Sept. 1, 1907.) 18 pp. Price, 5 cents.

S45. Radiometric Investigations of Infra-Red Absorption and Reflection Spectra . . . . . *W. W. Coblentz*

The fact that certain groups of elements have characteristic absorption bands is applied to substances containing water of constitution and water of crystallization. It is shown that in the former the oxygen and hydrogen atoms are not united, while in the latter they are united, giving the characteristic absorption spectrum of water. The second part of the paper gives the reflecting power of various metals, not investigated heretofore, and of various minerals, especially of the silicates. (Sept. 1, 1907.) 22 pp. Price, 10 cents.

S46. A Vacuum Radiomicrometer . . . . . *W. W. Coblentz*

This is a modification of the instrument devised by Boys, and includes also a combination of the Nichols radiometer with the radiomicrometer. The paper indicates directions in which further improvements are possible. (Sept. 15, 1907.) 5 pp. Price, 5 cents.

S47. On the Geometrical Mean Distances of Rectangular Areas and the Calculation of Self-Inductance . . . . . *Edward B. Rosa*

It is shown in this paper that Maxwell's correction term in the formula for the self-inductance of a coil of wire, depending on the difference in the mutual inductances of round and square wires, is wrong, and Stefan's only approximately correct. The formulas are fully worked out by the method of geometrical mean distances and verified by other methods, and the true correction term for different cases is calculated. Further use of the method of geometrical mean distances in the calculation of inductances is indicated. (Nov. 1, 1906.) 41 pp. Price, 10 cents.

S48. The Compensated Two-Circuit Electrodynamometer . . . . . *Edward B. Rosa*

The instrument is used especially for the accurate measurement of alternating current and power. The theory of the instrument is given and a compensation provided so that when calibrated by means of direct current it is correct for alternating currents of different frequencies and any magnitude. (Nov. 1, 1906.) 16 pp. Price, 10 cents.

S49. Complete Form of Fechner's Law . . . . . *P. G. Nutting*

A mathematical investigation of the quantitative relation between luminous intensity and visual sensation based on König's data on least perceptible increment. (Dec. 15, 1906.) 6 pp. Price, 5 cents.

S50. A Comparison of the Unit of Luminous Intensity of the United States with those of Germany, England, and France . . . . . *Edward P. Hyde*

A number of seasoned incandescent lamps were carried abroad and measured in authoritative laboratories in the three countries named. The ratios of the units obtained through them are compared with the ratios generally accepted and with those obtained in other recent investigations. (Jan. 15, 1907.) 16 pp. Price, 10 cents.

S51. Geometrical Theory of Radiating Surfaces with Discussion of Light Tubes . . . . . *Edward P. Hyde*

Assuming Lambert's cosine law and the inverse square law to apply to infinitesimal surfaces, the errors incident to applying them to finite surfaces are deduced for several simple cases. From a consideration of the case of an infinitely long, uniformly bright strip of finite width a theory of light tubes is developed. (Jan. 15, 1907.) 24 pp. Price, 10 cents.

S52. The Influence of Basic Lead Acetate on the Optical Rotation of Sucrose in Water Solution . . . . . *F. J. Bates and J. C. Blake*

An experimental investigation of the change in the polarization of sucrose produced by the addition of different amounts of basic lead acetate. (Jan. 15, 1907.) 9 pp. Price, 5 cents.

S53. On the Colorimetric Determination of Iron with Special Reference to Chemical Reagents . . . . . *H. N. Stokes and J. R. Cain*

A method of separating iron from materials in which it exists in minute traces and of determining it colorimetrically as sulphocyanate (Jan. 20, 1907.) 42 pp. Price, 10 cents.

S54. On Sulphocyanic Acid . . . . . *H. N. Stokes and J. R. Cain*

An improved method of preparing sulphocyanic acid, especially for colorimetric iron determinations, with observations on its properties and those of some of its derivatives. (Jan. 20, 1907.) 5 pp. Price, 5 cents.

S55. Radiation from and Melting Points of Palladium and Platinum . . . . . *C. W. Waidner and G. K. Burgess*

Radiation from platinum by several methods: Measurements of black-body temperature of iridium furnace at instant of melting of these metals. Melting point on thermoelectric scale. Optical determinations of temperature, using red, green, and blue light, based on Wien's equation for monochromatic radiation. (Mar. 4, 1907.) 46 pp. Price, 10 cents.

S56. The Mutual Inductance of a Circle and a Coaxial Single-Layer Coil. The Lorenz Apparatus and the Ayrton-Jones Absolute Electrodynamometer . . . . . *Edward B. Rosa*

A series formula is developed for calculating the mutual inductance of a circle and a coaxial single-layer coil. The formula is more convenient than one using elliptic integrals and is very accurate. Several examples are given to test and illustrate the formula. (Mar. 1, 1907.) 28 pp. Price, 10 cents.

S57. On the Establishment of the Thermodynamic Scale of Temperature by Means of the Constant-Pressure Gas Thermometer . . . . . *Edgar Buckingham*

A discussion of the methods for finding the thermodynamic corrections of the gas thermometer, together with computations of these corrections for the nitrogen thermometer and comparisons with values given by previous writers. (Feb. 4, 1907.) 57 pp. Price, 15 cents.

S58. An Exact Formula for the Mutual Inductance of Coaxial Solenoids . . . . . *Louis Cohen*

An exact formula in elliptic integrals is derived for the mutual inductance of two coaxial, concentric single-layer solenoids. (Mar. 14, 1907.) 9 pp. Price, 5 cents.

S59. The Mutual Inductance of Coaxial Solenoids . . . . . *E. B. Rosa and Louis Cohen*

A critical examination of various formulas for calculating the mutual inductance of coaxial solenoids, with numerical examples to test and illustrate the formulas. (Mar. 30, 1907.) 22 pp. Price, 10 cents.

S60. The Production of High Frequency Oscillations from the Electric Arc . . . . . *L. W. Austin*

An experimental study of the "singing arc" as a source of high frequency oscillations. (Apr. 1, 1907.) 16 pp. Price, 5 cents.

S61. An Explanation of the Short Life of Frosted Lamps . . . . . *Edward P. Hyde*

The rapid decrease in candlepower of frosted lamps is due, at least partly, to the increased absorption of the carbon film deposited on the inner side of the bulb. Owing to the diffuse reflection at the frosted surface a relatively large part of the emitted light is compelled to traverse the absorbing carbon film three or more times before finally emerging. Results of confirmatory experiments are given. (Mar. 23, 1907.) 4 pp. Price, 5 cents.

S62. Melting Points of the Iron-Group Elements by a New Radiation Method . . . . . *G. K. Burgess*

Minute quantities of substances melted on platinum ribbon, the temperature of which is measured by means of an optical pyrometer. Method designed for rare substances was tested by determining melting points of Fe, Ni, Co, etc. (Apr. 5, 1907.) 11 pp. Price, 10 cents.

S63. On the Determination of the Mean Horizontal Intensity of Incandescent Lamps . . . . . *E. P. Hyde and F. E. Cady*

A continuation of a previous investigation on this subject. (See reprint No. 43.) Other types of lamps are studied, and the methods and results of similar experiments by Uppenborn are discussed. (Apr. 30, 1907.) 13 pp. Price, 10 cents.

S64. The Simultaneous Measurement of the Capacity and Power Factor of Condensers . . . . . *Frederick W. Grover*

Four methods for obtaining the ratio of the capacities and the difference of the power factors of two condensers are described and critically compared. Using air condensers as standards, examples are given to show what values of power factor occur in mica and paper condensers by different manufacturers. (May 23, 1907.) 61 pp. Price, 15 cents.

S65. A New Determination of the Ratio of the Electromagnetic to the Electrostatic Unit of Electricity . . . . . *E. B. Rosa and N. E. Dorsey*

An extended experimental investigation of the problem, by the method of capacities, employing spherical, cylindrical, and plane condensers. A detailed mathematical discussion of the theory and of sources of error is given. The result, reduced to vacuo, obtained for the ratio of the units is $2.9971 \times 10^{10} \left[\frac{\text{cm Int. } \Omega}{\text{sec}}\right]^{1/2}$. (The National Physical Laboratory has found (Phil. Trans., 214A, pp. 27–108, 1914) that 1 international ohm is equal to 1.00052 absolute ohms. On the substitution of this value in the above ratio it becomes $2.9979 \times 10^{10} \frac{\text{cm}}{\text{sec}}$. The estimated uncertainty is 1 in 10 000.) (May 20, 1907.) 170 pp. Price, 20 cents.

S66. A Comparison of the Various Methods of Determining the Ratio of the Electromagnetic to the Electrostatic Unit of Electricity . . . . . *E. B. Rosa and N. E. Dorsey*

A discussion of the relative advantages and disadvantages of the various methods of determining the ratio of the units that have been used or proposed. (June 21, 1907.) 18 pp. Price, 5 cents.

S67. Preliminary Specifications for Clark and Weston Standard Cells.....*F. A. Wolff and C. E. Waters*

Specifications for the construction of Clark and Weston Standard Cells and for the preparation and purification of the materials employed, based in the main on the results obtained in an investigation on the reproducibility and constancy of both types. (See S70.) (Aug. 16, 1907.) 18 pp. Price, 5 cents.

S68. Calorimetric Resistance Thermometers and the Transition Temperature of Sodium Sulphate. .....*H. C. Dickinson and E. F. Mueller*

Description of platinum resistance thermometers having very small time constant. Calibration on International Hydrogen Scale and application to determination of transition temperature of sodium sulphate. [Superseded by S200.] (June 21, 1907.) 21 pp. Price, 5 cents.

S69. On the Standard Scale of Temperature in the Interval 0° to 100°..*C. W. Waidner and H. C. Dickinson*

Results of intercomparisons of primary standard mercurial thermometers and relation of the temperature scale of the Bureau of Standards to the International Hydrogen Scale of Temperature. The depression and zero recovery of verre dur glass. Description of thermometer comparator, standard barometers, etc. (May 3, 1907.) 66 pp. Price, 20 cents.

S70. Clark and Weston Standard Cells..... .....*F. A. Wolff and C. E. Waters*

An investigation of the accuracy attainable in the reproduction of standards of electromotive force, with detailed descriptions of the purification and preparation of the necessary materials and of the apparatus and methods employed. The results obtained and the close agreement of the Bureau cells with those set up by other investigators establish the suitability of the cell as a fundamental electrical standard. (Sept. 17, 1907.) 80 pp. Price, 20 cents.

S71. The Electrode Equilibrium of the Standard Cell... .....*F. A. Wolff and C. E. Waters*

A study of the conditions of equilibrium in both limbs of the cell, made in order to detect possible causes of variation in electromotive force due to secondary chemical reactions which may take place between the ingredients of the cell. (Oct. 4, 1907.) 9 pp. Price, 5 cents.

S72. A Comparative Study of Plain and Frosted Lamps. .....*E. P. Hyde and F. E. Cady*

The various effects of frosting the bulbs of carbon filament incandescent lamps are studied as changes in (1) absorption, (2) distribution, and (3) life.

(1) New lamps show an absorption of only 2 or 3 per cent, which increases rapidly as the lamps burn. (2) The distribution of light around frosted lamps depends on (a) the distribution curve of the bare lamps, and on (b) the shape of the bulb. (3) The theory advanced in a previous paper (see reprint No. 61) to account for the short life of frosted lamps is further substantiated. Readings are given of the temperatures of the bulbs of plain and frosted lamps, both new and old. (July 15, 1907.) 30 pp.

S73. On the Variation of Resistances with Atmospheric Humidity.....*E. B. Rosa and H. D. Babcock*

It is shown in this paper that resistances that have been coated with shellac undergo changes in value due to the absorption of moisture by the shellac, and that the resistance increases in a moist atmosphere and decreases in a dry atmosphere. This occurs even if the resistances are kept submerged in oil. A thorough study has been made of resistances of various kinds, and the magnitude of changes occurring and methods of preventing it are given. (Oct. 4, 1907.) 20 pp. Price, 10 cents.

S74. On the Self-Inductance of a Toroidal Coil of Rectangular Section . . . . . *Edward B. Rosa*

The simple formula for the self-inductance of such a coil assumes that the current flows in a thin current sheet about the core. Fröhlich's correction formula was derived on the assumption that a winding of round wires is equivalent to a thick current sheet. It is shown in this paper that this assumption leads to a wrong result, and the correct expression is given, enabling the self-inductance to be calculated when the size and spacing of the wires are given. (Aug. 10, 1907.) 7 pp. Price, 5 cents.

S75. On the Self-Inductance of Circles . . . . . *E. B. Rosa and Louis Cohen*

It is shown in this paper that some of the formulas that have been given for the self-inductance of circular conductors of circular cross section are incorrect, while the most accurate formulas and the most convenient approximate formulas are indicated and tested by numerical examples. (Aug. 10, 1907.) 11 pp. Price, 5 cents.

S76. The Influence of Frequency on the Resistance and Inductance of Solenoidal Coils . . . . . *Louis Cohen*

A theoretical investigation of the effect of frequency on the resistance and inductance of solenoids. The work of previous investigators is discussed, and it is pointed out that they do not agree with experiment. New formulas are derived which agree with the experimental results of M. Wien, and also with new experiments carried out by the author. (Aug. 16, 1907.) 19 pp. Price, 10 cents.

S77. The Atomic Weight of Hydrogen . . . . . *W. A. Noyes*

A determination of the ratio of hydrogen to oxygen by direct synthesis of water by the action of hydrogen on copper oxide and by the union of hydrogen and oxygen over palladium foil. (Sept. 11, 1907.) 26 pp. Price, 10 cents.

S78. The Best Method of Demagnetizing Iron in Magnetic Testing . . . . . *Charles W. Burrows*

An experimental investigation to determine a method of freeing iron from previous magnetization preliminary to a permeability test. The influence of the frequency of reversal, the number of reversals, the upper and lower limits of the current, and the method of regulating the demagnetizing current, as well as the influence of eddy currents, temperature, and gentle vibrations, are investigated. A method of procedure for a complete ballistic test is outlined. (Sept. 3, 1907.) 70 pp. Price, 15 cents.

S79. A Deflection Potentiometer for Voltmeter Testing . . . . . *H. B. Brooks*

In this paper the theory of the deflection potentiometer is extended (see Paper No. 33 preceding). The instrument is used for the measurement of electromotive force and current by a combination of the null and deflection methods. A second instrument constructed on this plan is described, and a brief outline of the method of design of such instruments is given. [Superseded by S172 and S173.] (Oct. 11, 1907.) 26 pp. Price, 10 cents.

S80. The Self and Mutual Inductance of Linear Conductors . . . . . *Edward B. Rosa*

Formulæ are given for the self and mutual inductance of straight wires, flat strips, and rectangles, for the so-called noninductive arrangement of strips and sheets folded on themselves, and for a "noninductive" winding of wires on a cylinder or in a plane. It is shown how, by the use of geometrical mean distances and arithmetical mean distances and arithmetical mean square distances, certain formulas are derived independently and some approximate formulas made more accurate. (Sept. 15, 1907.) 44 pp. Price, 15 cents.

S81. The Atomic Weight of Chlorine . . . . . *W. A. Noyes and H. C. P. Weber*

A determination of the atomic weight of chlorine by the direct synthesis of hydrochloric acid by means of hydrogen and potassium chloroplatinate. (Oct. 1, 1907.) 20 pp. Price, 10 cents.

S82. The Preparation of Chloroplatinic Acid by Electrolysis of Platinum Black . . . . . *H. C. P. Weber*

A method of preparing chloroplatinic acid free from nitric acid by the electrolysis of finely divided platinum in concentrated hydrochloric acid. (Oct. 8, 1907.) 3 pp. Price, 5 cents.

S83. The Self-Inductance of a Coil of any Length and any Number of Layers of Wire . . . . *Edward B. Rosa*

The formulas of Weinstein and Stefan for the self-inductance of a circular coil of rectangular section are not accurate for long coils and no other formula yet given is accurate for such cases. In this paper it is shown how to calculate accurately the self-inductance of a coil of any length and any number of layers of wire, taking account also of the corrections depending on the size of the wire and the thickness of the insulation. (Oct. 12, 1907.) 23 pp. Price, 5 cents.

S84. The Self-Inductance of a Solenoid of any Number of Layers . . . . . *Louis Cohen*

In this paper is given the derivation of a simple approximate formula for the calculation of the self-inductance of a long coil of any number of layers, and examples are given to illustrate its use. (Oct. 11, 1907.) 8 pp. Price, 5 cents.

S85. Instruments and Methods used in Radiometry . . . . . *W. W. Coblentz*

An experimental investigation of sensitivity and relative advantages of the bolometer, radiomicrometer, radiometer, and thermopile, with a review of published data relating to these instruments and to galvanometers of high sensitivity. (Oct. 1, 1907.) 70 pp. Price, 15 cents.

S86. A Quartz Compensating Polariscope with Adjustable Sensibility . . . . . *Frederick Bates*

The theory and description of a new type of quartz-wedge polariscope which gives the maximum theoretical sensibility, whatever the character of the substance polarized. (Oct. 15, 1907.) 6 pp. Price, 5 cents.

S87. An Apparatus for Determining the Wave Form of Magnetic Flux . . . . . *M. G. Lloyd and J. V. S. Fisher*

Gives a description of apparatus by means of which the form factor of an electric wave may be directly determined and waves of magnetic flux or of electric current or voltage plotted. (Nov. 15, 1907.) 10 pp. Price, 10 cents.

S88. The Effect of Wave Form upon the Iron Losses in Transformers . . . . . *Morton G. Lloyd*

This article considers the two elements of core losses in transformers, hysteresis and eddy currents, and the effect of variations of wave form upon them. Assuming the effective voltage to be maintained constant, it is shown that the loss by eddy currents will be constant, while the hysteresis loss varies in a way which can be determined if the form factor of the applied voltage be known. Experimental data are given which substantiate the theoretical results. (Oct. 31, 1907.) 34 pp. Price, 10 cents.

S89. The Luminous Properties of Electrically Conducting Helium Gas . . . . . *P. G. Nutting*

An experimental study of the amount of light emitted by a column of helium gas as affected by the current, potential gradient, gas density, diameter of tube, orientation of tube, current frequency, and with age. The results are discussed from the point of view of a possible primary light standard. (Dec. 1907.) 13 pp. Price, 10 cents.

S90. Function of a Periodic Variable given by the Steady Reading of an Instrument; with a Note on the Use of the Capillary Electrometer with Alternating Voltages . . . . . *Morton G. Lloyd*

In general, instruments read the *effective* and not the average value of the quantity measured, even when the instrument has a proportional scale. It is shown that the capillary electrometer may be used with alternating voltages, but it is not well adapted for this class of work. (Dec. 30, 1907.) 8 pp.

S91. Selective Radiation from the Nernst Glower . . *W. W. Coblentz*

An experimental investigation of the distribution of energy in the spectrum of the Nernst glower when operated at various temperatures, from the lowest to the highest. It is shown that the infra-red emission spectrum, which is discontinuous at low temperatures, becomes continuous at high temperatures, but in neither case is there any evidence of the glower having a radiation law similar to that of a complete radiator. (Feb. 10, 1908.) 18 pp. Price, 10 cents.

S92. The Testing of Glass Volumetric Apparatus . . . . . *N. S. Osborne and B. H. Veazey*

Specifications of glass volumetric apparatus accepted for test. Discussion of these specifications. Experimental work on burette drainage and on effect of contamination on capacity of volumetric apparatus. Methods of testing. Tables for use in determination of capacity. (Apr. 10, 1908.) 49 pp. Price, 15 cents.

S93. Formulæ and Tables for the Calculation of Mutual and Self-Inductance . . . . . *E. B. Rosa and Louis Cohen*

The first part of the paper contains 121 formulas for the calculation of the mutual and self-inductance of coils of various kinds and of single conductors of different forms, together with the corrections to be applied in certain cases to convert the results of current sheet formulas and formulas assuming a uniform distribution of current over the section of a coil to the actual cases of current flowing in insulated wires. The formulas have all been tested in actual practice, and formulas that were found inaccurate or not practically useful have been eliminated in making the collection. The second part of the paper contains numerous examples to illustrate the use of the formulas. In an appendix 14 tables of functions and constants are given which are useful in the calculation of inductances. (Oct. 1, 1907.) 132 pp. [Superseded by S169.]

S94. Some Contact Rectifiers of Electric Currents . . . *L. W. Austin*

An experimental study of the unilateral conductivity of certain contacts (silicon-steel, carbon-steel, and tellurium-aluminum) for small currents. The percentage of rectification is independent of the frequency and the rectified current is roughly proportional to the square of the alternating current. (Apr. 27, 1908.) 15 pp. Price, 10 cents.

S95. A Method for Producing Feebly Damped High Frequency Electrical Oscillations for Laboratory Measurements . . . . . *L. W. Austin*

In this method the aperiodic pulses produced in a circuit of small inductance and large capacity connected across a buzzer contact are used to excite a highly inductive circuit to vibrate in its own natural period. (Apr. 27, 1908.) 4 pp. Price, 5 cents.

S96. On the Advantages of a High Spark Frequency in Radio-Telegraphy . . . . . *L. W. Austin*

It is shown that the telephone is much more sensitive to high tones and that the highly pitched spark is more easily heard in the midst of disturbing noises, also that the energy losses in sending stations are less with high spark frequency and lower potentials. (Apr. 27, 1908.) 5 pp. Price, 5 cents.

S97. Selective Radiation from Various Solids. I. . *W. W. Coblentz*

A spectrobolometric investigation of the radiation from various solids (oxides, silicates, etc.) in the form of (1) electrically heated rods similar to a Nernst glower, and (2) of solids in the form of a fine powder on a heater. It is shown that the partition of energy in the spectrum, of all the substances examined, is generally in the form of sharp emission lines superposed upon a weak continuous spectrum. With rise in temperature the spectrum usually becomes continuous. (May 20, 1908.) 32 pp. Price, 10 cents.

S98. Remarks on the Quartz Compensating Polariscope with Adjustable Sensibility . . . . . *Frederick Bates*

A simplified equation for calculating the zero point displacement is developed. Reply is made to Schönrock's criticism that it is necessary to consider the reflection and absorption in the small nicol of a Lippich system. It is shown that all the functions involved can be divided into linear and nonlinear functions and that the former, which include reflection, absorption, etc., impose no difficulties in the construction of the instrument. (June 2, 1908.) 6 pp. Price, 5 cents.

S99. Methods of Obtaining Cooling Curves . . . . . *G. K. Burgess*

The experimental methods available for obtaining cooling curves in thermal analysis with thermocouples for slow cooling, with and without registration, are classified and described. A simplification of the Roberts-Austen method is suggested. A brief analytical discussion of the characteristics of the several types of cooling curves is given. It is shown that the time-temperature and differential methods may be combined to give the highest sensibility over great temperature ranges. (Aug. 3, 1908.) 27 pp. Price, 10 cents.

S100. Note on the Approximate Value of Bessel's Functions for Large Arguments . . . . . *Louis Cohen*

A simple demonstration to show that the values of the Bessel's functions of complex arguments will be given approximately by certain exponential functions, when the absolute values of the arguments become very large. (Aug. 24, 1908.) 4 pp. Price, 5 cents.

S101. The Influence of Terminal Apparatus on Telephonic Transmission . . . . . *Louis Cohen*

A complete mathematical discussion of the problem of wave propagation along conductors taking into consideration the disturbing influences of terminal apparatus. It is shown that for short lines the telephone receiver increases the distortion while for very long lines the disturbing influences of the receivers are very slight. It is also shown that the introduction of a condenser of proper magnitude in series with the receiver will improve telephonic transmission. (Aug. 3, 1908.) 12 pp. Price, 10 cents.

S102. The Principles Involved in the Selection and Definition of the Fundamental Electrical Units to be Proposed for International Adoption . . . *F. A. Wolff*

A discussion prepared for the London Electrical Conference of 1908 on the relative merits of the standard cell and the silver voltameter as fundamental electrical standards. The superiority of the Weston standard cell in the light of the evidence at hand is pointed out and its adoption urged. (Sept. 3, 1908.) 18 pp. Price, 10 cents.

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S103. The Luminous Equivalent of Radiation.....*P. G. Nutting*

An extended study of the essential relations existing between light and radiation, visible sensation, and stimulus. A general theory of sensibility stimulus, and scale reading, applicable to all measuring instruments, is mapped out and the eye treated as a special case. The best available data are used to illustrate the theory, and finally special problems and practical applications are discussed. (Sept. 3, 1908.) 48 pp. Price, 15 cents.

S104. The Temperature Formula of the Weston Standard Cell.....*F. A. Wolff*

This paper gives the results of a redetermination of the temperature formula of the Weston normal cell. Over 150 cells, set up with material prepared or purified by different methods, including a number of cells exchanged with other investigators, were found in most excellent agreement between 0° and 40° C. (The formula proposed has been since adopted by the London International Electrical Conference.) (Sept. 3, 1908.) 28 pp. Price, 10 cents.

S105. Radiation Constants of Metals.....*W. W. Coblentz*

A spectrobolometric investigation of the radiation constants of various metals, including tungsten, tantalum, osmium, and platinum; also various forms of carbon filaments. Theoretical and experimental data are given to account for the high efficiency of the metal filament lamps. (Aug. 22, 1908.) 40 pp. Price, 10 cents.

S106. Dependence of Magnetic Hysteresis upon the Wave Form.....*Morton G. Lloyd*

Apparatus is described for measuring hysteresis with different wave forms, using the same definite value of maximum flux density, and it is shown that the hysteresis varies slightly with wave form. The separation of hysteresis and eddy-current losses by determining the total energy loss at two frequencies, using the Steinmetz formula, is not accurate, but is a close approximation when thin sheets are used. (Oct. 10, 1908.) 30 pp. Price, 10 cents.

S107. A New Form of Standard Resistance.....*E. B. Rosa*

A new form of standard resistance is described which has been found more constant and reliable than those heretofore used at the Bureau as standards, and which is also very convenient in use. These standards are so inexpensive and simple that any laboratory where precision measurements of resistance are made can afford to use them. Results of a long series of tests of the new standards are given. (Oct. 1, 1908.) 22 pp. Price, 15 cents.

S108. Errors in Magnetic Testing with Ring Specimens .....*Morton G. Lloyd*

Discussion of the errors which arise in measurements of permeability and hysteresis in rings of circular or rectangular section, due to nonuniform distribution of flux. Tables and curves are given showing, for rings of various dimensions, the ratio of mean intensity of magnetizing field to the intensity at the mean radius, and the ratio of hysteresis with uniform distribution to the actual hysteresis. (Aug. 19, 1908.) 19 pp. Price, 10 cents.

S109. The Testing of Transformer Steel..... .....*Morton G. Lloyd and J. V. S. Fisher*

A discussion of the conditions which should be realized in the measurement of energy losses in sheet steel subjected to alternating magnetization, and description of an apparatus giving 1 per cent accuracy with less than 2 kg of material. Results are given for domestic and foreign steels, showing a wide range of quality. Measurements at two frequencies have enabled the hysteresis and eddy-current losses to be separated. The effects of aging are shown to depend upon the flux density used for test, and are usually negligible in silicon steels. (Jan. 29, 1909.) 30 pp. Price, 5 cents.

S110. A New Method for Determining the Focal Length of a Converging Lens . . . . . *Irwin G. Priest*

An exposition of the theory, a description of the experimental procedure, and a discussion of the accuracy of a method giving the focal length in monochromatic light by means of the relation between focal length and the diameter of a circular interference fringe in the real image formed by the lens. The chief advantages of the method are (1) correct definition of focal length, (2) use of definitely specified wave lengths, affording a precise test of achromatism, and (3) simplicity of observation and calculation. 1(Mar. 18, 1909.) 15 pp. Price, 10 cents.

S111. A New Method for the Absolute Measurement of Resistance . . . . . *E. B. Rosa*

A method is described in which two coils of wire at right angles to one another form an armature, which revolves in a magnetic field produced by two parallel coils of many layers. Each revolving coil is connected to a 2-part commutator, which rectifies the current flowing through the coil. The method makes use of a 3-circuit differential galvanometer, by means of which the electromotive force generated by the revolving coils is balanced against the difference of potential at the terminals of the resistance to be measured, which may be from 1 to 10 ohms. The mutual inductance of the fixed and moving coils is determined by comparison with a standard of mutual inductance. (Feb. 27, 1909.) 10 pp. Price, 5 cents.

S112. The Theory of Coupled Circuits . . . . . *Louis Cohen*

A mathematical discussion of direct and electromagnetically coupled circuits. The frequency constants and damping factors are completely determined in both cases. For the case of electromagnetically coupled circuits expressions are also derived for the currents and potentials in the primary and secondary circuits. (Feb. 1, 1909.) 30 pp. Price, 5 cents.

S113. A Volt Scale for a Watts-per-Candle Meter . . *Herbert E. Ives*

The ordinary watt scale in a watts-per-candle or efficiency meter is replaced by a volt scale calculated on the voltage-watts-per-candle relation for the type of filament investigated. Incandescent lamps are photometered at a single voltage, and the photometer setting indicates on the volt scale the voltage to give a desired watts-per-candle. (Feb. 27, 1909.) 5 pp. Price, 5 cents.

S114. The Coefficient of Reflection of Electrical Waves at a Transition Point . . . . . *Louis Cohen*

An electric wave in passing from one conductor to another of different electrical constants will be partly reflected and partly transmitted. In this paper expressions are obtained giving the ratios of the amplitude of the reflected and transmitted waves to the incoming wave. It is shown that in some cases the potential may rise to double its value at a transition point. (Feb. 27, 1909.) 6 pp. Price, 5 cents.

S115. A Tungsten Comparison Lamp in the Photometry of Carbon Lamps . . *Herbert E. Ives and L. R. Woodhull*

A tungsten lamp is substituted for the usual carbon comparison lamp in commercial incandescent lamp photometry. Operated at low voltage the tungsten lamp gives a color match with carbon lamps of all commercial efficiencies, therefore eliminating the errors due to color differences. At the voltage used such a comparison lamp is very constant in candlepower and has an extremely long life. (Feb. 27, 1909.) 4 pp.

S116. The Determination of the Ratio of Transformation and of the Phase Relations in Transformers . . . . . *E. B. Rosa and Morton G. Lloyd*

A discussion of the factors affecting the ratio and phase relations in potential and current transformers, with experimental results. The effect of wave form upon the ratio is given especial attention. (Feb. 25, 1909.) 30 pp. Price, 5 cents.

S117. The Determination of the Magnetic Induction in Straight Bars.....*Charles W. Burrows*

A modification of the double-yoke method of magnetic measurements on straight bars. Uniform solenoids surround the two straight test pieces. Short coils are placed over the ends of the rods as close to the yoke as possible. The currents through these three sections are adjusted until the flux throughout the magnetic circuit as indicated by the test coils is uniform. The induction is then determined by balancing the electromotive forces, induced in a test coil and in the secondary of a variable mutual inductance. Both the induction and magnetizing force are determined by zero methods, and the constants of the apparatus are so adjusted that these quantities are read directly from the settings of a potentiometer. The effects of yokes, joints, leakage, compensating magnetomotive forces, position of test coils, nonuniformity of specimen, etc., are investigated experimentally. (May 1, 1909.) 58 pp. Price, 15 cents.

S118. A Method for Constructing the Natural Scale of Pure Color.....*P. G. Nutting*

Measurements of the least difference in wave length perceptible as a difference in color give reciprocal visual sensibility. The general integral of sensibility as a function of wave length gives the color scale desired.

Discussion of color units and application of method to the best recent data on the difference limen. (Apr. 27, 1909.) 5 pp. Price, 5 cents.

S119. An Approximate Experimental Method for the Analysis of EMF Waves.....*P. G. Agnew*

A method is discussed which gives approximate values of two harmonics of an emf wave, without the use of special apparatus, and requiring only voltmeter, ammeter, and condensers. It is shown by experimental results that an accuracy of 2 or 3 per cent may be attained. (Apr. 5, 1909.) 12 pp. Price, 5 cents.

S120. The Thermoelectric Properties of Tantalum and Tungsten.....*W. W. Coblentz*

This paper gives an account of an examination of the thermoelectric behavior of tantalum, tungsten, and constantan through the temperature range between −190° to +270° C. (Jan. 15, 1909.) 4 pp. Price, 5 cents.

S121. The Estimation of the Temperature of Copper by Means of Optical Pyrometers.....*G. K. Burgess*

An experimental determination of the corrections to be added to the readings of optical and total-radiation pyrometers when sighted upon liquid copper and cuprous oxide. These corrections, in the case of liquid copper, are over 125° C for pyrometers using red light and over 450° C for total-radiation pyrometers. The emissivities of copper and copper oxide are also determined. (June 17, 1909.) 9 pp. Price, 5 cents.

S122. The Resolving Power of Objectives.....*P. G. Nutting*

A half tone screen illuminated with monochromatic light as test object gave a simple and sensitive means of testing the well-known formula for resolving power. Different values of the resolving power constant were interpreted in terms of quality of image. The performance of telescope and camera objectives was compared as regards resolving power and residual axial aberrations. (Aug., 1909.) 5 pp. Price, 5 cents.

S123. The Theory of the Hampson Liquefier..*Edgar Buckingham*

The paper contains an account of the theory of the action of the Hampson apparatus for liquefying gases, and shows how the behavior of such an apparatus may be predicted from the known properties of the gas to be liquefied. The theoretical deductions are tested by comparison with the published results of experiments on the liquefaction of air and shown to agree with those results. Several questions concerning the operation of the liquefier are discussed in the light of the theory with a view to dispelling misunderstandings which have occurred. (May 15, 1909.) 33 pp. Price, 5 cents.

S124. Platinum Resistance Thermometry at High Temperatures.....*C. W. Waidner and G. K. Burgess*

Determination of the freezing and melting points of the metals Sn, Cd, Pb, Zn, Ag-Cu, Ag, and Cu, with thermometers of platinum of different degrees of purity, and of different types of construction, on the scale of the platinum thermometer, when calibrated in ice, steam, and sulphur vapor; comparison of this scale with the thermoelectric scale; variations in thermometers caused by high temperatures; differences in freezing points of metals obtained from different sources; heating of thermometers by measuring current; the boiling point of sulphur as a fixed point; modification of Callendar method of calibration for impure platinum; the Dickson formula; the Palladium thermometer; etc. (June 25, 1909.) 82 pp. Price, 10 cents.

S125. The Daylight Efficiency of Artificial Illuminants .....*Herbert E. Ives*

Paper discusses the possibility of screening high-efficiency illuminants so that the color is that of average daylight. The intensity of the source before and after screening is compared, and the values used to give a "daylight efficiency." Two methods of obtaining white-light efficiency are developed; the first, from consideration of absorbing screens; second, from the consideration of the white light which with a spectrum ray will match the color. The first method is limited to sources with continuous spectra and is dependent on an arbitrary "screening point." The second is applicable to all sources. A graphical combination of the results of the two methods enables all light sources to be represented in a form to be easily compared and to show the qualities desired by the illuminating engineer. (May, 1909.) 16 pp. Price, 5 cents.

S126. Coupled Circuits in which the Secondary has Distributed Inductance and Capacity.....*Louis Cohen*

A mathematical discussion of the oscillations in two circuits which are inductively connected, and one of which has distributed capacity and inductance. (July 29, 1908.) 8 pp. Price, 5 cents.

S127. Effect of Phase of Harmonics upon Acoustic Quality.....*M. G. Lloyd and P. G. Agnew*

A description of experiments which indicates that quality is independent of the phase of harmonics. Two electric generators giving frequencies in the proper relation are connected in series, and a telephone receiver used as a detector. By running the two generators slightly out of synchronism, a recurring shift of phase is produced. The sound from a telephone has also been analyzed by resonators and found to contain harmonics not present in the electrical wave used to excite it. (June 30, 1909.) 9 pp. Price, 5 cents.

S128. White Light from the Mercury Arc and its Complementary.....*Herbert E. Ives*

Various artificial light sources were measured for color with the Ives colorimeter and expressed in terms of average daylight. By plotting them in a color triangle (Maxwell) it appeared that the mercury vacuum arc was nearly complementary to all of the more usual yellowish illuminants. The Welsbach mantle and the tungsten lamp were found to be nearest the ideal complementary. The intensity relations were investigated and it was found that to 1 cp of mercury light should be added 0.57 cp of Welsbach, 0.54 cp of tungsten, or 0.50 cp of 3.1-watts-per-candle carbon glow lamp for the best approach to daylight. Illumination of colored objects showed the mercury-tungsten combination to be the best, rendering color values very much better than the mercury arc alone. The mercury-tungsten combination has an efficiency of 0.8 watt per candle, the carbon 1.4 watts per candle. (Aug. 1, 1909.) 7 pp. Price, 5 cents.

S129. The Regulation of Potential Transformers, and the Magnetizing Current....*M. G. Lloyd and P. G. Agnew*

A formula for regulation is derived by vector method and by use of complex quantities. The principal object is to show that the customary formula involving magnetizing current is incorrect. Experiments are given showing that regulation is independent of magnetizing current. (June 21, 1909.) 8 pp. Price, 5 cents. [Superseded by S211.]

S130. The Determination of the Constants of Instrument Transformers.....*P. G. Agnew and T. T. Fitch*

A null method for the simultaneous determination of the ratio and the phase angle of both potential and current transformers, which depends upon the potentiometer principle, is described. Curves are given showing the performance of typical transformers. It is shown that the constants of a current transformer may be changed by its magnetic treatment, but this effect may be removed by demagnetization. (July 5, 1909.) 19 pp. Price, 5 cents.

S131. Selective Radiation from Various Solids. II.....
.....*W. W. Coblentz*

The present paper is a continuation of previous work (No. 97) on this subject. Several minerals are shown to be solid solutions instead of definite chemical compounds, which suggests that this method of analysis might be of use in studying the physical condition of highly fusible oxides. The spectral energy curves of carbon and tungsten are set to a "color match," and it is shown that the eye is incapable of detecting a difference in emissivity of 5 per cent or more in the extreme red end of the spectrum. (Aug. 14, 1909.) 18 pp. Price, 10 cents.

S132. Luminous Efficiency of the Firefly.....
.....*Herbert E. Ives and W. W. Coblentz*

For the purpose of obtaining the spectral energy distribution of the firefly light, photographs were taken of the spectrum of the species "Photinus pyralis" and also of the carbon glow lamp. The densities of the negatives were measured, and the spectrophotometric curve of the firefly light thereby obtained was compared with that of carbon lamp. The spectral energy curve of the carbon lamp was determined by radiometric methods, and, by means of the ratios of the spectrophotometric intensities of the firefly light to the glow lamp, the spectral energy curve of the firefly was obtained. The luminous efficiency of the firefly and glow lamp was obtained from the spectral energy curves. The glow lamp (4 watt) proved to have 0.4 per cent efficiency, the firefly 96.5 per cent. (Aug. 1, 1909.) 15 pp. Price, 5 cents.

S133. Luminosity and Temperature.....*P. G. Nutting*

Making use of the luminosity function developed in a previous paper, the complete expressions for luminosity and luminous efficiency of bodies of known temperatures are worked out. In conclusion, numerical values are calculated in candles per watt for various lamps and other bodies and the results found to be in close agreement with known data. (July, 1909.) 10 pp. Price, 5 cents.

S134. A Theoretical and Experimental Study of the Vibration Galvanometer.....*F. Wenner*

The importance of the electromotive force developed by the relative motion of the magnet and winding of a galvanometer is pointed out and the general theory of the vibration galvanometer developed. Equations are derived which show how the amplitude of the vibration depends upon the constants of the instrument and the conditions under which it is used. The design of an instrument to be used in bridge work is considered, and it is shown that the mechanical power necessary to maintain a vibration is the principal factor in determining its sensibility. (May 25, 1909.) 32 pp. Price, 5 cents.

S135. Specific Heat of some Calcium Chloride Solutions between $-35°$ C and $+20°$ C. . . . . *H. C. Dickinson, E. F. Mueller, and E. B. George*

A continuous flow calorimeter for specific heat of solutions at low temperatures. The Dewar flask adapted for use directly as the calorimeter. Energy and temperature measurements made electrically. Specific heats of chemically pure and commercial calcium choride solutions of various densities at temperatures from $-35°$ to $+20°$ C determined by these two methods. (Nov. 4, 1909.) 30 pp. Price, 10 cents.

S136. On the Definition of the Ideal Gas . . . . . *Edgar Buckingham*

The paper contains a discussion of the nature, origin, and limitations of the notion of an ideal or standard gas having properties to which those of real gases may be considered as approximations, a comparison of the more common ways of defining these properties in terms of Boyle's and Joule's laws and the Joule-Kelvin effect, showing to what extent the various forms of definition are equivalent; and a discussion of the term "cohesion-pressure" and of its use in the definition of the ideal gas. (Nov. 13, 1909.) 21 pp. Price, 5 cents.

S137. Mica Condensers as Standards of Capacity . *Harvey L. Curtis*

The important methods of measuring capacity are discussed with reference to their use in the case of mica condensers. It is shown that: (1) The temperature coefficient of a mica condenser can be made small by compressing it, when the paraffin is molten, between metal clamps; (2) the effect of changes in the atmospheric pressure on the capacity is small, but not always negligible; (3) the capacity is independent of the voltage except in the case of silvered-mica condensers; (4) the capacity of a mica condenser kept at constant temperature and pressure remains constant to a few parts in a hundred thousand; (5) the capacity with alternating current of infinite frequency is the same as the capacity with instantaneous discharge using direct current. (Apr. 22, 1910.) 58 pp. Price, 10 cents.

S138. The Mutual Inductances of Two Parallel Coaxial Circles in Terms of Hypergeometrical Series . . . . . *Frederick W. Grover*

In a paper published in the Journal de Physique of 1901, Mathy derived a formula for the mutual inductance of two parallel coaxial circles, in which the result is expanded in hypergeometrical series. This formula was tested by the author of this paper and found to give erroneous results. In this paper the derivation of Mathy's formula is investigated and the corrected formula obtained. Part of the error in Mathy's formula is shown to be due to use of erroneous equations in Halpher's "Fonctions elliptiques." Finally numerous examples are given to illustrate the use of the formula. (Feb. 1, 1910.) 14 pp. Price, 5 cents.

S139. A New Method for the Absolute Measurement of Electric Quantity . . . . . *Burton McCollum*

In the methods previously used for the absolute determination of the electrochemical equivalent of silver it is necessary first to measure a current absolutely, and then hold this current constant for a measured length of time from which the quantity is calculated. It is here shown how an electrodynamometer of a modified Gray type may be used to indicate directly either the current or the total quantity of electricity that has passed through it, and a method is given for determining the constant of the instrument in such a way that errors in measuring the coils or small variations in their dimensions are reduced many times in their effect on the calculated value of electric quantity. (May 20, 1910.) 24 pp. Price, 5 cents.

S140. The Comparative Sensitiveness of some Common Detectors of Electrical Oscillations...*Louis W. Austin*

Article describes method of producing high-frequency currents in a buzzer circuit and two methods of comparing the sensitiveness of detectors.

I. By varying the coupling between the exciting and the receiving circuits until the signals become inaudible in the detector telephones.

II. By noting the shunt across the telephones necessary to produce silence.

The detectors in the order of their sensitiveness are as follows: The Audion (Vacuum Detector); the Electrolytic; the Perikon with emf; the Magnetic; the Perikon without emf; and the Fleming Vacuum Detector. (Mar. 1, 1910.) 16 pp. Price, 5 cents.

S141. Photometric Units and Nomenclature.....*E. B. Rosa*

A systematic discussion of the mathematical and physical relations of photometric quantities, and a derivation of some useful formulas. Photometric nomenclature is considered and some new proposals made. Several problems are given for illustration. (May 10, 1910.) 30 pp. Price, 5 cents.

S142. A Modified Method for the Determination of Relative Wave-Lengths.....*Irwin G. Priest*

A method especially adapted to the establishment of secondary standards.

Characteristics of the Method: (1) Use of circular interference fringes. (2) Use of the double increment in the distance between two mirrors as difference of path. (3) Use of method of flexure to measure "fractions."

Accuracy attained: (1) Average residual (7 determinations) 1 part in 8 400 000. (2) Maximum residual (7 determinations) 1 part in 3 900 000. (3) Error of method is within accidental errors.

Advantages of Method: (1) Rigorous control of errors. (2) Small chance of apparatus and personal error. (3) Few chances for accidental error. (4) Automatic elimination of temperature error without thermostat. (5) Automatic elimination of error of "dispersion of phase." (June, 1910.) 34 pp. Price, 5 cents.

S143. Note on the Temperature Scale Between 100 and 500° C .....*C. W. Waidner and G. K. Burgess*

A continuation of the work of Reprint 124, being the determination of the boiling point of naphthaline and benzophenone by means of the platinum resistance thermometer on the scale defined by ice, steam, and sulphur (444.70).

Discussion of the work of other observers on these points suggests the following scale good to 0.1 C as defined by constant volume nitrogen thermometer.

Freezing points.		*Boiling points.*	
Tin	231.9 C	Naphthaline	218.0 C
Cadmium	321.0 C	Benzophenone	306.0 C
Zinc	419.4 C	Sulphur	444.7 C

(May 13, 1910.) 8 pp. Price, 5 cents.

S144. A New Form of Direct-Reading Candlepower Scale and Recording Device for Precision Photometers.....*George W. Middlekauff*

The photometer settings are automatically recorded by dots on a sheet of paper on which is printed a new form of candlepower scale that perfectly adapts itself to the record, thus permitting the candlepower to be read off directly in terms of one or more standards without computation. (June 6, 1910.) 33 pp. Price, 10 cents.

S145. A Device for Measuring the Torque of Electrical Instruments.....*P. G. Agnew*

A device is described which was designed specifically for the measurement of the torque of electrical instruments, but which is generally applicable to the measurement of small horizontal forces. It consists essentially of a pendulum, of which the bob traverses a scale ruled concentrically on a concave spherical surface. (June 27, 1911.) 4 pp. Price, 5 cents.

S146. The Intensities of Some Hydrogen, Argon, and Helium Lines in Relation to Current and Pressure . . . . . *P. G. Nutting and Orin Tugman*

The intensities of spectrum lines are known to vary widely with the condition of the gas or vapor emitting them. This paper contains the results of a study of the visible spectra of hydrogen, argon, and helium contained in Plucker tubes. The curves given show the variations in the intensities of about 20 lines with varying current and gas density. Potential gradient as a function of current was determined for hydrogen and helium, so that for these gases line intensity is known as a function of the internal energy of the gas.

Finally a summary of the important new results is given. (Aug. 6, 1910.) 22 pp. Price, 10 cents.

S147. The Temperature Coefficient of Resistance of Copper . . . . . *J. H. Dellinger*

For representative samples of the copper now furnished for electric uses, the temperature coefficient was found to be very nearly proportional to the conductivity. The 20° C temperature coefficient of a sample of copper is given by multiplying the number expressing the per cent conductivity by 0.00394. (Conductivity of 100 per cent is taken as corresponding to a resistivity of 0.153022 ohm (meter, gram) at 20° C.) Expressed otherwise, the change of resistivity per degree centigrade of any sample of copper is 0.000598 ohm (meter, gram) or 0.00681 microhm-centimeter.

[June 4, 1914.—Since this paper was written an international conductivity standard has been adopted. The temperature coefficient corresponding to the resistivity adopted as standard is 0.00393 at 20° C, replacing 0.00394 above.]

Bending and winding are shown to produce no material change in the temperature coefficient.

It is shown that the measurement of temperature coefficient offers an advantageous substitute for the direct measurement of conductivity in a number of cases. (July 12, 1910.) 31 pp. Price, 10 cents.

S148. The Electrical Conductivity of Commercial Copper . . . . . *F. A. Wolff and J. H. Dellinger*

The mean per cent conductivity found for a large number of samples of annealed copper wire from important refiners and wire manufacturers was 100.07 per cent. A mean communicated by a large wire-manufacturing company of careful tests representing over 100 000 000 pounds of wire was 100.25 per cent. It is therefore proposed that the formerly assumed standard value, 0.153022 ohm (meter, gram) at 20° C, be used in the preparation of wire tables for annealed copper and in the expression of per cent conductivity. The resistivity of hard-drawn No. 12 copper wire was found to be 2.7 per cent greater than that of annealed copper. The advantages of the expression of resistivity in ohms (meter, gram) are set forth. The desirability of an international agreement on copper conductivity standards is urged. (Aug. 1, 1910.) 24 pp. Price, 10 cents.

June 4, 1914.—An international agreement was attained in September, 1913. The International Electrotechnical Commission adopted a value based on this experimental work, but slightly different from it numerically. The international standard resistivity is 0.15328 ohm in a uniform wire 1 m long weighing 1 g, at 20° C.]

S149. On the Constancy of the Sulphur Boiling Point . . . . . *C. W. Waidner and G. K. Burgess*

The constancy of the temperature within the standard form of S. B. P. apparatus is studied both with a resistance thermometer of 9 mm length and 13.1 ohms and with thermocouples. When the latter are homogeneous, both methods give consistent results showing temperatures within the radiation shield to be constant to within 0.05° C over 27 of 30 cm of S vapor column. (Dec. 6, 1910.) 4 pp. Price, 5 cents.

S150. Note on Oscillatory Interference Bands and Some of Their Practical Applications..... .....*G. O. Squier and A. C. Crehore*

Simple applications of optical interference were studied from the standpoint of their use in measuring periodic phenomena. The instrument used was essentially a pair of parallel glass plates in contact, illuminated by a mercury-vapor lamp. Vibration produced by varying mechanical pressure, by local variations of heat produced electrically, by alternating magnetic or electric fields operating on a metal plate on which the glass plates were mounted, all produced measurable displacements of the interference bands. The sensitiveness of these arrangements was not great with the form of apparatus used. (Sept. 1, 1910.) 12 pp. Price, 10 cents.

S151. The Effect of Preliminary Heating Treatment upon the Drying of Clays.....*A. V. Bleininger*

Investigation undertaken to ascertain the possibility of using excessively plastic clays which on drying show losses due to cracking and checking, by subjecting the clays in the crude state to a preliminary heat treatment before working them by the usual methods.

Preheating offers a possible commercial method for the treatment of excessively plastic clays which can not be worked and dried successively by other means, subject to certain limitations. Methods and conditions are discussed. (Dec. 6, 1910.) 53 pp. [Now known as T1.]

S152. The Reflecting Power of Various Metals....*W. W. Coblentz*

This paper gives an illustrated description of an investigation of the reflecting power of various pure metals, including tungsten, molybdenum, tantalum, graphite, antimony, silicon, chromium, etc. The results obtained give additional evidence to previous observations, showing that a common property of pure metals is a low reflectivity in the visible spectrum and explains the high luminous efficiency of the tungsten and other metal filament lamps. Several supplementary notes are added in which are given the thermoelectric power of molybdenum-copper, comments on the radiation laws of metals, etc. (Dec. 6, 1911.) 53 pp. Price, 10 cents.

S153. The Action of Sunlight and Air upon Some Lubricating Oils.....*C. E. Waters*

By the combined action of sunlight and air certain lubricating oils were found to yield a solid oxidation product within six hours, the amount increasing at a slowly diminishing rate, but not ceasing after four months' continual exposure. The oils gained in weight in spite of the water and carbon dioxide, as well as traces of volatile oily matter, that were given off.

The increase in the acidity of the oils was also determined.

The oil filtered from the oxidation product was found to contain considerable combined oxygen. (Sept. 29, 1910.) 8 pp. Price, 5 cents.

S154. The Visibility of Radiation. A Recalculation of König's Data.....*P. G. Nutting*

This is a supplementary note and correction to the previous paper on the Luminous Equivalent of Radiation. From the paper reprinted in his works, it appears that König's data on Equivalent Slit Widths had not been corrected for variable prismatic dispersion. This dispersion is given in a later paper and is now applied to correct the visibility curves so much used in spectrophotometry and in problems in illumination. The most notable effect of the correction is the shift of the maximum at high intensities from 565 back to 544. (Oct. 1, 1910.) 4 pp. Price, 5 cents.

S155. A Photometric Attachment for Spectroscopes.... .....*P. G. Nutting*

For simplicity and convenience the polarization spectrophotometers are far ahead of other types, but have lacked sensibility and precision. In the new form an image of the finely ruled dividing surface is thrown on the slit of any spectroscope (wave length, high intensity, high dispersion). Tests of an instrument show that it has the highest sensibility of which the eye is capable, good light, economy, and, of course the dispersion of any spectroscope to which it is attached. The scale correction is shown to be negligible by three different tests. (Oct. 1, 1910.) 3 pp. Price, 5 cents.

S156. Selective Radiation from Various Substances. III.....*W. W. Coblentz*

An investigation of the emission and the absorption of the acetylene flame and the Welsbach mantle. The acetylene flame has an absorption band in the orange yellow, with regions of greater transparency in the violet and in the red.

It is shown that the spectral energy curves of the Welsbach mantle and of the same material used as a solid electrically heated glower are entirely different, due to the great difference in the thickness of the radiating layer. Further experiments are described on the question of color match versus spectral intensity match, showing that the superposition of the spectral energy curves of two widely different sources of radiation holds true over only a very short spectral region. (Nov. 9, 1910.) 52 pp. Price, 10 cents.

S157. The Measurement of Electric Oscillations in the Receiving Antenna.....*L. W. Austin*

The paper shows a method of calibrating a crystal detector connected to a galvanometer by comparing it with a thermoelement. The detector and galvanometer can then be used for quantitatively measuring the received oscillatory current in the antenna, even in the case of the weakest signals detectable by ordinary methods. (Oct. 1, 1911.) 5 pp. Price, 5 cents.

S158. Some Experiments with Coupled High-Frequency Circuits.....*L. W. Austin*

The author measures the current strength in two tuned circuits with different values of the coupling and of the logarithmic decrement of the sending circuit, and treats similarly the case where one of the two circuits is untuned. The effect on the damping of increasing the coupling of the detector circuit is also investigated. The importance of providing means for varying the amount of energy drawn from the antenna is emphasized, since it is shown that if the coupling of the detector circuit is made stronger than is required for the maximum effect, the damping is increased, resulting in loss of sharpness of tuning. (May 1, 1910.) 14 pp. Price, 5 cents.

S159. Some Quantitative Experiments in Long Distance Radiotelegraphy.....*L. W. Austin*

Being an account of experiments carried on between the U. S. S. *Birmingham*, U. S. S. *Salem*, and the wireless station at Brant Rock, Mass. Measurements were made on sending and received currents at distances up to 1000 miles. From these observations a formula has been deduced which gives the received current which may be expected in the day for any sending current, any distance, any antenna height, and any wave length. The formula has been verified for sending currents from 7 to 30 amperes, antenna heights from 30 to 130 feet, wave lengths from 300 to 3750 meters, and distances up to 1000 miles. Night signals do not accord with this formula, but are entirely irregular, sometimes being no stronger than the day signals, and sometimes being of vastly greater intensity. (Feb. 1, 1911.) 49 pp. Price, 10 cents.

S160. The Behavior of High-Boiling Mineral Oils on Heating in the Air.....*C. E. Waters*

Results of "carbonization" tests of gas-engine oils when heated in flasks; also when heated in tubes of glass, brass, cast iron, and different steels. The tests made in tubes show some evidence of catalytic effects and indicate possible variations due to fatty oil, a question which will be taken up in the near future. (Dec. 14, 1910.) 12 pp. Price, 5 cents.

S161. The Determination of Vanadium in Vanadium and Chrome-Vanadium Steels.....*J. R. Cain*

Errors in the usual methods for determining vanadium in steels are considered and methods of eliminating or correcting for some of these are discussed. A new method, based on precipitation of the vanadium by cadmium carbonate, followed by electrolysis, reduction, and titration, is described. (Apr. 24, 1911.) 16 pp. Price, 5 cents.

S162. On the Computation of the Constant c_2 of Planck's Equation by an extension of Paschen's Method of Equal Ordinates.....
.....*Edgar Buckingham and J. H. Dellinger*

Two methods of computing the maximum wave length and the constant c_2 of Planck's equation from an observed energy curve of a black-body radiator, by a modification of Paschen's method of using the wave lengths for equal ordinates, are given. The first is an approximate method, substituting the corrected values of the observed wave lengths in the usual Paschen equation. The second method gives an expression based directly on Planck's equation, which is very simple in application. The paper concludes with a note on "corresponding points" of energy curves. (Apr. 26, 1911.) 14 pp. Price, 5 cents.

S163. A Comparison of American Direct-Current Switchboard Voltmeters and Ammeters.....
.....*T. T. Fitch and C. J. Huber*

The article is an account of a comparative test of American switchboard voltmeters and ammeters. Tables are given showing the performance and construction, and the relation between the two is discussed. Some figures and photographs are also included. The different makes of instruments do not differ greatly from one another in design and performance. (Mar. 1, 1911.) 22 pp. Price, 5 cents.

S164. A Study of the Current Transformer with Particular Reference to Iron Loss.....*P. G. Agnew*

It is shown that the ratio and phase angle of the current transformer may be predicted from the magnetic constants of the core, and quantitative relations are established connecting the slope of the ratio curve with the empirical equations for iron loss. Quantitative determinations of the amount of wave distortion introduced by the transformer and of the effect of wave form on the ratio and phase angle are given. Incidentally it is shown that the methods commonly in use for the determination of the Steinmetz exponent are incorrect for the case for a variable exponent. (June 1, 1911.) 52 pp. Price, 10 cents.

S165. Thermodynamics of Concentration Cells..*Henry S. Carhart*

This paper discusses the equation $A=H+T.\ dA/dT$ as a general expression of the laws of thermodynamics, and particularly in the specific form of the Helmholtz equation $E=H/nF+T.\ dE/dT$.

The two cases selected for special attention are: First, when H the change in internal energy is a constant, dA/dT, or dE/dT, is then zero and the relation between A or E and T is linear; second, an examination of Nernst's expression for A in terms of integral powers of T. Nernst makes the coefficient of the first power of T necessarily zero.

After a mathematical demonstration that this coefficient is not zero the paper proceeds to the experimental investigation of the emf of various concentration cells with amalgams of different concentration as the electrodes, and in every case a linear relation is established between the emf and temperature. This relation is excluded by the Nernst hypothesis.

The paper concludes with a description of two calomel cells, one with a positive temperature coefficient and the other with an equal negative one. When the two are connected in series the sum of their electromotive forces is independent of temperature. (June 1, 1911.) 20 pp. Price, 15 cents.

S166. The Capacity and Phase Difference of Paraffined Paper Condensers as Functions of Temperature and Frequency .....*Frederick W. Grover*

Measurements of the capacity and phase difference of 13 paper condensers were made at temperatures ranging from 10° to 35° C, with alternating current of frequencies of from 33 to 1000 cycles per second. Then results are given in the form of curves, which show that the changes of the

capacity and phase difference, under these varying conditions, are important, and in the majority of cases of such a nature as to render paper condensers unsuitable as standards of capacity. In many cases the observed energy losses in the condensers were very large. The observed curves are compared with those demanded by various theories of absorption, with the result that only the modification of Pellat's theory, suggested by Von Schweidler, was found competent to represent all the observations. (Feb. 28, 1911.) 82 pp.

S167. The Steam-Turbine Expansion Line on the Mollier Diagram and a Short Method of Finding the Reheat Factor . . . . . *Edgar Buckingham*

After general introductory sections the form of the steam-turbine expansion line on the Mollier diagram is discussed and a method is given for finding the reheat factor—a quantity useful to the designer in drawing the expansion line. (Mar. 2, 1911.) 39 pp. Price, 10 cents.

S168. Radiometric Investigation of Water of Crystallization, Light Filters, and Standard Absorption Bands . . . . . *W. W. Coblentz*

The present paper contains further contributions (see S45) to the question of the manner in which water is contained in minerals. A detailed examination was made of the absorption spectra of opal and tremolite in various states of dehydration. The former shows the absorption bands of water, while the latter does not, although it is supposed to contain dissolved water. The radiometric test finds no distinction between "water of crystallization," "dissolved water," "absorbed water," and water in "solid solution," all of which give absorption bands identical with those of water in its free liquid state. Minerals containing "water of constitution" do not show the absorption bands of water.

The paper contains also the transmission and reflection spectra of a miscellaneous collection of substances, including sylvite and quartz glass.

On "light filters" it is shown that a 2-cm thickness of a 2 per cent solution of cupric chloride absorbs all the infra-red beyond 0.67 μ and transmits 80 per cent in the green and blue. Standard spectral lines are given for calibrating prisms. (May 16, 1911.) 45 pp. Price, 10 cents.

S169. Formulas and Tables for the Calculation of Mutual and Self-Inductance. (Third edition, revised and enlarged) . . . . . *Edward B. Rosa and Frederick W. Grover*

This third edition of formulas and tables for the calculation of mutual and self-inductance is based on the first edition by Edward B. Rosa and Louis Cohen. (See S93.) It includes practically all the matter contained in the first edition, but in addition to a thorough revision, in which some errors have been corrected and some formulas extended, a large amount of new matter has been added both in the body of the paper and in the tables. [See also S320.] (Dec. 18, 1916.) 237 pp. Price, 20 cents.

S170. The Correction for "Emergent Stem" of the Mercurial Thermometer . . . . . *Edgar Buckingham*

The paper contains a description of Guillaume's and Mahlke's methods for determining the stem correction, with convenient tables for use with Mahlke's method. The theory of the two methods is discussed, together with several subsidiary matters necessary to the precise exposition of the theory, and the treatment is illustrated by numerical examples. (July 13, 1911.) 29 pp. Price, 5 cents.

S171. A Determination of the International Ampere in Absolute Measure . . . . . *E. B. Rosa, N. E. Dorsey, and J. M. Miller*

The paper gives an account of the development of an improved form of Rayleigh current balance, and the accurate determination of the ratio of the radii of the fixed and moving coils of the balance by electrical means,

without direct measurement of the radii. It then gives the result of several series of measurements in which the emf of the Weston normal cell in terms of the international ohm and the current balance is found to be 1.01822 semiabsolute volts. Experiments at the Bureau during the past year show that the absolute ampere as determined by the current balance gives for the electrochemical equivalent of silver, using both the porous pot form and the nonseptum form of voltameters, 1.11804 mg per coulomb instead of 1.11800 mg as adopted by the London conference.

The computed probable error of the above value of the emf of the Weston normal cell (so far as the current balance measurements are concerned) is 3 parts in 1 000 000. The authors give 2 in 100 000 as the possible uncertainty in the value due to all causes. (Sept. 9, 1911.) 125 pp. Price, 20 cents.

S172. Deflection Potentiometers for Current and Voltage Measurements . . . . . *H. B. Brooks*

This paper gives an outline of the elementary principles of the null potentiometer as used for current and voltage measurements. The essential principles of the deflection potentiometer (see S33 and S79, preceding) are stated, and two recent instruments of this kind are described, each of which is suitable for both current and voltage measurements. The theory of the deflection potentiometer used with current shunts is developed, and a special set of values for such shunts is shown to give economy of time in testing, with reduced computation and less liability of error. (June 23, 1911.) 23 pp. Price, 10 cents.

S173. Outline of Design of Deflection Potentiometers, with Notes on the Design of Moving-Coil Galvanometers . . . . . *H. B. Brooks*

This paper outlines the principles on which deflection potentiometers are designed, and gives a numerical example. It includes some notes on the fundamental constants of the moving-coil galvanometer, and shows how to change the field strength, spring strength, and size of wire in order to secure a desired galvanometer performance. A procedure is outlined which is intended to facilitate the production in quantity of galvanometers whose resultant performance is satisfactory, while allowing some latitude in the values of individual constants. (June 23, 1911.) 26 pp. Price, 5 cents.

S174. The Determination of Total Sulphur in India Rubber . . . . . *C. E. Waters and J. B. Tuttle*

Comparative determinations by different methods, especially a number of variations of the method of Henriques. These determinations were made on rubber and also on a sample of very dilute sulphuric acid. The amount of error caused by the presence of lead sulphate was also determined.

The method adopted and used for some time in our routine work is a modification of that of Henriques. The rubber is attacked by nitric acid saturated with bromine, instead of using nitric acid alone. (July 19, 1911.) 9 pp. Price, 5 cents.

S175. The Measurement of the Inductances of Resistance Coils . . . . . *Frederick W. Grover and Harvey L. Curtis*

The method to be chosen for the measurement of a given inductance depends on the order of magnitude of its time constant. In this paper are considered only time constants of less than 10^{-5} second, such as occur in "noninductive resistances" and multipliers. The measurements naturally fall into two classes, those on coils with resistances of 1000 ohms or less, and those on coils of resistances greater than 1000 ohms. In the case of coils of the latter class effects due to the capacity of the coil with respect to earth become important, and the absolute potential of the coil must be taken into account. Methods are developed by which a good degree of accuracy may be attained with time constants of the order of 10^{-7}. (Sept. 1, 1911.) 31 pp. Price, 10 cents.

S176. The Luminous Properties of Electrically Conducting Helium Gas. II. Reproducibility . . *P. G. Nutting*

This paper gives the results of photometric and spectrophotometric tests of a set of 38 helium tubes made up and operated as shown most advisable by preliminary work. The tubes do not differ measurably in color. In light emission per cm of capillary the average deviation is 1.15 per cent, the maximum deviation 3 per cent, the uncertainty in observation being 1 per cent. (Aug. 25, 1911.) 8 pp. Price, 5 cents.

S177. Resistance Coils for Alternating Current Work . . . . . *H. L. Curtis and Frederick W. Grover*

An ideal resistance coil for alternating current work would have zero phase angle at all frequencies and its resistance would be independent of the frequency. Commercial coils do not fulfill these conditions. In this paper there is given a discussion of the conditions which must be fulfilled in order that such a coil may be realized, and this discussion is followed by an application of the principles evolved to the design of coils of resistances varying from 0.1 to 10 000 ohms. There is also a discussion of the methods of connecting the coils in resistance boxes. (Sept. 1, 1911.) 23 pp. Price, 5 cents.

S178. The Hydrolysis of Sodium Oxalate and Its Influence Upon the Test for Neutrality . . . . . *William Blum*

In connection with the testing of sodium oxalate for use as a primary standard for acidimetry and oxidimetry, a knowledge of the normal alkalinity of the pure salt is important. The purest sodium oxalate that could be made was found to produce in 0.1 molar solution a pink color with phenolphthalein, equivalent to 4 per cent transformation of the indicator, and 6 per cent in 0.2 molar solution. This value was not in accord with that calculated from the theory of hydrolysis, using the present accepted values for the various constants. The error produced by neglecting this alkalinity in determinations of the purity of the salt was found to equal about 0.02 per cent, which is negligible for practical purposes. The action of sodium-oxalate solution on various kinds of glass, and the behavior of such solutions on heating, was also studied. A method for the accurate testing of the neutrality of sodium oxalate is described. (Nov. 9, 1911.) 20 pp. Price, 5 cents.

S179. Wave Lengths of Neon . . . . . *I. G. Priest*

Ten wave lengths resulting from determinations by the method described in Reprint 142, Bulletin of the Bureau of Standards, are presented in a table. The precision, reliability, and accuracy of these values are discussed. The probable errors are all less than 1 part in 10 000 000, and the values are considered accurate to within about 1 or 2 parts in 6 000 000. (Nov. 23, 1911.) 6 pp. Price, 5 cents.

S180. On the Deduction of Wien's Displacement Law . . . . . *Edgar Buckingham*

The deduction contains the following four parts, which are, in substance, common to all such deductions: (*a*) The treatment of the change of period of diffuse radiation when it is compressed adiabatically; (*b*) the treatment of the accompanying change of energy density; (*c*) the demonstration that black radiation remains black in such a process; and (*d*) the use of the Stefan-Boltzmann law to correlate the results of (*a*), (*b*), and (*c*). Some novelties are introduced in the methods used in the steps (*a*) and (*b*), while the remaining steps of the argument are given, more briefly and with no innovations, for the sake of completeness of form. The object of the paper is to improve the clearness and simplicity of the deduction without sacrifice of rigor. (Feb. 28, 1911.) 13 pp. Price, 5 cents.

S181. The Four-Terminal Conductor and the Thomson Bridge . . . . . *Frank Wenner*

The conditions which must be fulfilled in order that a four-terminal conductor have a definite resistance or both a definite resistance and inductance are pointed out. The relation between the different resistances and some of the points to be observed in the design of resistance standards

which are to carry large alternating current are discussed. The way in which measurements with the Thomson bridge are carried out at the Bureau is described and it is shown that the adjustments made give the same simple relations between the resistances whether the four-terminal conductors are linear or not. The adjustments which should be made when alternating current is used are also considered. (Mar. 8, 1912.) 52 pp. Price, 5 cents.

S182. Standardization of Potassium Permanganate Solution by Sodium Oxalate . . . . . *R. S. McBride*

The effects of temperature, acidity, volume of solution, rate of titration, access of air, and presence of added manganous sulphate upon the value obtained for a permanganate standardized against sodium oxalate were determined and the necessary end-point corrections fixed. Loss of oxygen during titration is probably responsible for the observed variations, but none of these exceeds one-half per cent. The following procedure is recommended: Dissolve 0.25–0.3 g of sodium oxalate in 200–250 cc of 5 per cent (by vol.) sulphuric acid at 80–90°, and titrate at once, *stirring the solution vigorously and continuously.* The main part of the permanganate should be added not more rapidly than 10–15 cc per minute, and the last ½–1 cc dropwise. A correction for the amount of permanganate necessary to produce the end point is desirable. (June 1, 1912.) 32 pp. Price, 5 cents.

See also (on pp. 90, 91, 92) Circulars 14, 19, 25, and 26.

S183. Benzoic Acid as an Acidimetric Standard . *George W. Morey*

The value of benzoic acid as an acidimetric standard was tested by comparing the values obtained by standardizing a hydrochloric-acid solution by several standard methods with the values obtained by standardizing both sodium and barium hydroxide with benzoic acid. The results show that the benzoic-acid method is accurate, and that fact, combined with other advantages, makes benzoic acid an excellent material for an acidimetric standard. (May 4, 1912.) 8 pp. Price, 5 cents.

S184. A Tubular Electrodynamometer for Heavy Currents . . . . . *P. G. Agnew*

The instrument described has a capacity of 5000 amperes. The field "coil" consists of two coaxial copper tubes, and since there is axial symmetry the torque is independent of the current distribution in the tubes. Hence it is suitable for an a. c.–d. c. transfer instrument. Details of construction are given. (July 17, 1912.) 8 pp. Price, 5 cents.

S185. Thermometric Lag . . . . . *D. R. Harper 3d*

The theory of the lag of a thermometer in acquiring the temperature of a medium in which it is immersed, and experimental tests of the theory. The dependence on the nature of the medium and the rate of stirring of the same is considered. Common "chemical" mercurial thermometers, Beckmann thermometers, thermocouples, electrical resistance thermometers, and galvanometers are each treated in turn. Special cases, including calorimetry, are developed fully, with numerous examples and instructions for the computation of lag corrections to thermometer readings. (Mar. 5, 1913.) 56 pp. Price, 10 cents.

S186. Determination of Manganese as Sulphate and by the Sodium Bismuthate Method . . . . . *William Blum*

The most accurate method of obtaining a known amount of manganese to serve as a primary standard is by weighing $MnSO_4$. A study of the temperature of decomposition of this salt showed that it may and must be heated for a considerable period at 450°–500° to obtain the pure compound. The use of sodium oxalate for standardizing permanganate solutions for the bismuthate method is recommended, as it is more convenient to use than manganous sulphate and is equally accurate. A study of the effect of conditions upon the results by the bismuthate method showed that accurate results may be obtained over a wide range of conditions, making this method applicable to the analysis of materials containing large or small amounts of manganese. (June 21, 1912.) 26 pp. Price, 5 cents.

S187. A New Precision Colorimeter . . . . . *P. G. Nutting*

A new colorimeter of high precision recently designed by the author is described. This is of a new type, namely, a monochromatic analyzer. Its readings give the dominant hue (or its complementary) and per cent white in the color analyzed, whether from a source of light, a transmission screen, or a mat surface. The theory and various methods of use of the instrument are described. (July 25, 1912.) 5 pp. Price, 5 cents.

S188. Instruments and Methods Used in Radiometry—II . . . . . *W. W. Coblentz*

The paper gives an account of the attainments in spectroradiometry since 1907. (See S85.) This includes air and vacuum bolometers, thermopiles, and radiomicrometers; linear and surface thermopolies of bismuth and silver; new combinations of instruments; and (Note I) the Callendar radiobalance. (Dec. 8, 1911.) 27 pp. Price, 10 cents.

S189. Antenna Resistance . . . . . *L. W. Austin*

As shown in a previous note, antenna resistance varies, in accordance with theory, approximately inversely as the square of the wave length, for wave lengths less than twice the fundamental of the antenna. Above this the resistance increases in proportion to the wave length. This increasing resistance is believed to be connected with the losses due to the currents in the earth near the antenna. The results were verified by three methods, the "artificial-antenna," the "decrement," and the "half-deflection" methods. The minimum resistance in well-installed ship antennas was a little above 2 ohms, which was lower than for land stations. (Mar. 1, 1912.) 8 pp. Price, 5 cents.

S190. Energy Losses in Some Condensers Used in High-Frequency Circuits . . . . . *L. W. Austin*

The energy loss in a compressed-air condenser was measured by the "decrement" method, and the loss in various other condensers was obtained by substitution of the former with resistance in series. Leyden jars in air had an equivalent resistance of 1.0 to 1.8 ohms, at 14 500 volts. Their resistance in oil was only a few tenths of an ohm, showing that the loss in air is largely due to brush discharge. Condensers in which brush discharge was prevented by their construction had only a few tenths of an ohm resistance, which did not change, from 4000 to 20 000 volts. The resistance of paper and micanite condensers was 2 to 3 ohms. The resistance of Leyden jars in air, between 10 000 and 20 000 volts, increased approximately in proportion to the square of the voltage. (Mar. 1, 1912.) 8 pp. Price, 5 cents.

S191. Selective Radiation from Various Substances, IV. . . . . *W. W. Coblentz*

The present paper contains further contributions to the study of the radiating properties of various substances. (See S91, S97, S131, S156.) This includes a determination of (I) the radiation constants of platinum (see S105), (II) the emission spectrum of neon and helium, (III) the emissivity of different parts of an acetylene flame, (IV) the variation of emissivity with thickness of the radiating layer, (V) the radiation from a uniformly heated cavity and from its inclosing walls, (VI) standard spectral energy curves (Note I), light filters which absorb all the infra-red (see S168), and (Note II) transmission of prism material. (June 5, 1912.) 37 pp. Price, 10 cents.

S192. On a Modified Form of Stability Test for Smokeless Powder and Similar Materials . . . . . *H. C. P. Weber*

The test consists in the determination of the length of time which elapses until the sample explodes at various constant temperatures. The temperatures chosen are 160° C, 170° C, 180° C, and 200° C. Comparisons are made with samples of powder tested according to the customary methods. The curves which are obtained are discussed from the point of view of change of the rate of decomposition with change of temperature. The necessary

apparatus is described and the classification of powders according to this test is indicated. The accuracy with which results may be expected to be duplicated is shown by numerous repetitions and check results. (June 22, 1912.) 11 pp. Price, 5 cents.

S193. Atomic Weight of Bromine.....*H. C. P. Weber*

The ratio of the atomic weights of hydrogen and of bromide is obtained by determining the amount of bromine which a weighed quantity of hydrogen will remove from potassium bromoplatinate. The hydrobromic acid formed is also weighed. From 10 determinations 20 values are obtained giving the ratio H: Br equal to 1: 79.306 [6] with a probable error of ±0.0014. Taking the atomic weight of hydrogen as 1.00779 (O=16) the atomic weight of bromine is 79.924. (Nov. 1, 1912.) 20 pp. Price, 5 cents.

S194. The Silver Voltameter—Part I. First Series of Quantitative Experiments.....
.....*E. B. Rosa and G. W. Vinal*

This paper reviews briefly the large amount of material that has been previously published on the silver voltameter and outlines the present investigation, which is to be published in four papers, this being the first. The apparatus and methods used throughout the investigation for making the deposits are described in detail. The results of 121 deposits, which constitute the first series of quantitative experiments, are recorded. They were mostly made in the filter-paper and porous-cup voltameters and show a marked difference in the results of these two forms. Proof is given that this is due to the filter paper being chemically active and not due to a complexion, as previously supposed. [See also S285.] (Aug. 1, 1912.) 57 pp. Price, 10 cents.

S195. The Silver Voltameter—Part II. The Chemistry of the Filter-Paper Voltameter and the Explanation of Striations.....
.....*E. B. Rosa, G. W. Vinal, and A. S. McDaniel*

Part I of this series of papers showed that the difference between the porous-cup and filter-paper voltameters was due to the filter paper acting on the silver nitrate. The object of the present paper is to discover the nature of this effect. Some other substances, mostly organic, were found to produce similar effects to filter paper. It was found that filter paper spontaneously decomposes into oxycelluloses that by reduction cause a precipitate of colloidal silver in the electrolyte. Striations were found to be due to the presence of this silver colloid which breaks up the crystalline structure of the silver deposit and causes it to grow in the direction of the convection currents of liquid. [See also S285.] (Oct. 1, 1912.) 74 pp. Price, 20 cents.

S196. The Diffuse Reflecting Power of Various Substances.....*W. W. Coblentz*

This paper gives data on the reflection power of matte surfaces of various substances, for the spectral regions of 0.54, 0.60, 0.95, 4.4, 8.8, and 24μ. The substances examined include lampblack, plantinum black, pigments, white paints, green leaves, cloth, and building material. The object of the investigation was to find the blackest and the whitest substances, the former to be used as absorbing surfaces of radiometers, the latter to be used as a covering for observatory buildings exposed to intense sunlight. The paper gives also the variation in the reflecting power of polished silver with variation in the angle of incidence. (Nov. 4, 1912.) 43 pp. Price, 10 cents.

S197. Density and Thermal Expansion of Ethyl Alcohol and of Its Mixtures with Water.....
.....*N. S. Osborne, E. C. McKelvy, and H. W. Bearce*

This paper contains the description of and experimental results on the purification and preparation of anhydrous ethyl alcohol, the thermal expansion and density of this alcohol and its mixtures with water, the alcoholometric tables derived from these results, accompanied by a comparison with the results of other investigators, and a bibliography of the literature of the subject. (Apr. 15, 1913.) 148 pp. Price, 25 cents.

S198. A Micropyrometer.....*G. K. Burgess*

An incandescent lamp is mounted within the Huyghens eyepiece of an ordinary microscope, which is then used as a Morse or Holborn-Kurlbaum pyrometer. Combined with a suitable furnace such as a Pt strip heated electrically in vacuo or suitable gas as H, melting points and emissivities of minute specimens (0.01 to 0.001 mg or less) are readily observed. Best calibrated empirically with known melting points. (Dec. 9, 1912.) 4 pp. Price, 5 cents.

S199. A Simplified Formula for the Change in Order of Interference Due to Changes in Temperature and Pressure of Air.....*I. G. Priest*

In the interference method for expansion coefficients a correction must be applied to the observed change in the order of interference, to take account of any change in the density of the air. A much simpler formula is presented in this paper as a substitute for the Pulfrich formula. (October, 1912.) 3 pp. Price, 5 cents.

S200. New Calorimetric Resistance Thermometers.....
.....*H. C. Dickinson and E. F. Mueller*

Description of new calorimetric resistance thermometers designed by the authors and now in use at the Bureau. A simplified method for making the calculations is given. (Jan. 1, 1913.) 10 pp. Price, 5 cents.

S201. The Silver Voltameter—Part III. Second Series of Quantitative Experiments and the Preparation and Testing of Silver Nitrate.....
.....*E. B. Rosa, G. W. Vinal, and A. S. McDaniel*

The second series of quantitative experiments extending from December 17, 1909, to April 1, 1910, is given in detail together with investigations of the "volume effect," the temperature coefficient, and the material for the cathode. The methods employed to test the electrolyte for acidity and for reducing impurities are described and the methods of purifying the silver nitrate discussed. It is shown that the processes ordinarily used are insufficient, but that it is possible to obtain salt of sufficient purity by following the special procedure which is outlined. [See also S285.] (Jan. 1, 1913.) 59 pp. Price, 10 cents.

S202. Note on Cold-Junction Corrections for Thermocouples.....*P. D. Foote*

This paper directs attention to the considerable errors that may be introduced into technical measurements by failure to apply the cold-junction correction and considers in detail the methods of applying this correction together with a brief consideration of the devices used for the elimination of the cold-junction correction. (Apr. 15, 1913.) 13 pp. Price, 5 cents.

S203. Analysis of Alternating-Current Waves by the Method of Fourier, with Special Reference to Methods of Facilitating the Computations...
.....*F. W. Grover*

The natural method for the analysis of alternating electromotive force and current curves is by means of the classic equations of Fourier, but on account of the labor involved, recourse is often had to graphical or approximate methods. Runge has shown that, by grouping similar terms the number of terms which need to be calculated in the Fourier method may be materially reduced, but his work does not seem to be generally known. The present paper has for its purpose the presentation of the method of Runge in a form which shall be of especial service in making numerical computations. By systematic arrangement of the work and by use of tables here given the labor of calculation has been very considerably reduced. Examples of the analysis of actual, experimentally obtained curves are given, which illustrate the methods of computation and the practical applications which may be made of the results of the analyses. (May 15, 1913.) 80 pp. Price, 20 cents.

S204. The Constants of Spectral Radiation of a Uniformly Heated Enclosure or So-called Black Body, Part I . . . . . *W. W. Coblentz*

In the present paper are given the results of a determination of the constants of spectral radiation from a uniformly heated enclosure. This enclosure was formed within a long narrow porcelain tube, around which was wound a thin platinum ribbon, which was heated to incandescence by means of electric current. The spectrum was produced by means of a mirror spectrometer and a perfectly clear fluorite prism. The distribution of energy in the spectrum was measured by means of a vacuum bolometer, and the constants were computed by means of the Planck equation. (Jan. 15, 1913.) 77 pp. Price, 10 cents.

S205. Melting Points of the Refractory Elements. I. Elements of Atomic Weight from 48 to 59 . . . . . *G. K. Burgess and R. G. Waltenberg*

Micropyrometric measurements of the melting points in hydrogen of the elements Ni, Co, Fe, Mn, Cr, Va, Ti. Discussion of methods. Results:

Ni 1452±3	Mn 1260±20	Va 1720±20
Co 1478±5	Cr 1520 to>Fe?	Ti 1794±12.
Fe 1530±5		

(April 25, 1913.) 14 pp. Price, 5 cents.

S206. High-Frequency Ammeters . . . . . *J. H. Dellinger*

For the measurement of current in the range of radiotelegraphic frequencies 50 000 to 2 000 000 cycles per second, it is general practice to use the hot-wire ammeter or a modification of it. Its superiority is due to the simplicity of form which the portion of the circuit within the instrument may have, permitting a minimum of self-inductance and capacity. When the instrument is required to carry relatively large currents, a simple single wire is not sufficient, and more than one elementary path must be provided for the current. Then the current distribution, and consequently the indicated current, change as the frequency is varied. All types of ammeters in use for the measurement of large high-frequency currents are found to be subject to serious errors at radiotelegraphic frequencies. Mutual inductance between parts is in some cases the determining factor in the change of current distribution. Capacity of parts is found to cause no error for frequencies below 1 000 000; although above that, it may, so that two instruments in series may be carrying different amounts of current. Inductive action of the instrument leads in some cases causes appreciable errors. The various types of instrument are investigated both experimentally and theoretically, and ways of overcoming the various errors are devised. (Apr. 3, 1913.) 69 pp. Price, 10 cents.

S207. A Comparative Study of American Direct-Current Watthour Meters . . . . . *T. T. Fitch and C. J. Huber*

A large amount of numerical data is given in regard to the performance and construction of six types of American meters. The total friction torque is separated into four parts—brush, gearing, bearing, and windage friction—and curves are plotted of these components of torque against speed. Also a description is given of the method used in obtaining these curves. The load curve is analyzed and its shape is shown to depend upon the heating of the series element, the variation in the friction torque, and the back electromotive force. (July 11, 1913.) 30 pp. Price, 15 cents.

S208. Windage Resistance of Steam-Turbine Wheels . . . . . *Edgar Buckingham*

A general equation deduced from the theory of dimensions is shown to agree with such experimental data on windage as have been published, but these data are not adequate as a basis for the computation of windage corrections, except in a few simple cases. The data are analyzed and suggestions offered as to practical computation. By applying the principle of dynamical similarity it is shown that model experiments may be utilized and the practicability of such experiments is discussed. (July 25, 1913.) 44 pp. Price, 10 cents.

S209. Latent Heat of Fusion of Ice.....
H. C. Dickinson, D. R. Harper 3d, and N. S. Osborne

Measurements by two independent methods in a precision calorimeter are described in the paper. Samples of ice containing from 100 to 500 g each were cooled to fixed known temperatures, weighed, and introduced into the water of the calorimeter. In one method the heat to melt the ice was supplied electrically, the temperature of the calorimeter remaining nearly constant; in the other, the method of mixtures, the heat was supplied by the cooling of the calorimeter. The first gives the result primarily in joules based on the electric units; the second gives it in calories. The apparatus, the procedure, and the results obtained are fully discussed. (Aug. 20, 1913.) 32 pp. Price, 10 cents.

S210. Observations on Ocean Temperatures in the Vicinity of the Icebergs and in Other Parts of the Ocean.....
....*C. W. Waidner, H. C. Dickinson, and J. J. Crowe*

The paper discusses the records of ocean temperatures obtained in the vicinity of icebergs and in other parts of the ocean by the Bureau party on board the U. S. S. *Chester* and U. S. S. *Birmingham* in June and July, 1912. The records show that in parts of the ocean where some of these records were taken the temperature variations due to mixing currents are so large that no certain conclusion can be drawn from temperature records as to the proximity of icebergs. The results of other experiments, such as variation in salinity, the detection of echoes both aerial and submarine, temperature records in approaching icebergs along different courses, vertical temperature distribution near icebergs, etc., are briefly considered. (Aug. 1, 1913.) 14 pp. Price, 10 cents.

S211. Accuracy of the Formulas for the Ratio, Regulation, and Phase Angle of Transformers.....
.....*P. G. Agnew and F. B. Silsbee*

A derivation of the formulas for ratio, regulation, and phase angle is given, showing by numerical example the magnitude of the approximations involved. Values computed for two types of lighting transformers from short-circuit data are compared with values obtained from direct measurement and the results found to agree within the experimental error. (July 11, 1913.) 15 pp. Price, 5 cents.

S212. Melting Points of Some Refractory Oxides....*C. W. Kanolt*

The materials were heated in a graphite resistance furnace and heating curves were plotted. The temperatures were measured with an optical pyrometer. CaO and MgO could not be melted in a vacuum on account of vaporization, but were heated at atmospheric pressure. In this case special precautions were necessary to avoid smoke, which causes low pyrometer readings. One method consisted of inserting into the material to be melted a tube of tungsten or graphite, removing smoke from the tube by a current of gas, and sighting the pyrometer into the tube. A method applied to lime consisted of making the lime into a tube, supporting the tube by its open upper end, which was at a low temperature, and sighting the pyrometer into the lower end, which was heated, smoke being removed by a current of hydrogen.

Oxide	Melting point	Supporting material
Cr_2O_3	1990°	Tungsten, graphite
Al_2O_3	2050°	Tungsten, graphite
CaO	2572°	Tungsten, CaO
MgO	2800°	Graphite

(June 1, 1913.) 19 pp. Price, 5 cents.

S213. Critical Ranges A2 and A3 of Pure Iron..... .....*G. K. Burgess and J. J. Crowe*

Following a summary of previous work, an account is given of a thermal study of the location and nature of A2 and A3 using 15 samples of Fe and improved experimental methods. Some 130 heating and cooling curves were taken. The effects of preparation of the sample and of rate of heating were determined. Reduced to zero rate, and for gas-free iron in vacuo, $Ac2=Ar2=768\pm0.5$, $Ac3=909\pm1$, and $Ar3=898\pm2$. (Sept. 22, 1913.) 56 pp. Price, 20 cents.

S214. Note on the Setting of a Mercury Surface to a Required Height.....*M. H. Stillman*

The paper describes an improvement in the method of setting a mercury surface to a given height by bringing it just into contact with a downward projecting pointer. The improvement consists in placing a parallel-ruled scale back of the pointer so that its image will appear in the mercury surface at the end of the pointer. Distortion of the lines of this image indicates contact. Results of experiments showing the accuracy of this method are given. (Sept. 20, 1913.) 4 pp. Price, 10 cents.

S215. Micrometer Microscopes.....*Arthur W. Gray*

The first section points out numerous sources of error generally overlooked in using micrometer microscopes, and gives examples to illustrate the magnitude of the corrections needed for a few microscopes that have been investigated. The second section describes a simple and rapid method of applying the proper corrections when making length measurements of precision. The third section explains an accurate means of measuring screw errors and a graphical procedure for computing convenient correction tables. (Nov. 5, 1913.) 16 pp. Price, 5 cents.

S216. The Pentane Lamp as a Working Standard..... .....*E. C. Crittenden and A. H. Taylor*

This paper recommends the use of tested pentane lamps as secondary standards of candlepower when electric standards are not available, and gives a detailed statement of the method of testing followed at the Bureau, with general directions for the use of the lamps. The effects of variation in pentane and in atmospheric conditions are discussed, a correction for the former is proposed, new determinations of the humidity correction factor are given, and a chart is provided to facilitate the reduction of observations to normal candlepower. (Aug. 2, 1913.) 27 pp. Price, 5 cents.

S217. Testing Potential Transformers.....*H. B. Brooks*

Describes a method of measuring the ratio and phase angle of a potential transformer in terms of the known ratio and phase angle of another transformer used as a standard. The instruments required are a portable wattmeter and an ammeter. The test may be carried out with current from commercial circuits, as ordinary fluctuations of voltage have no effect on the readings. The accuracy is ample for commercial requirements. The method may also be used to determine the regulation of power transformers. (Feb. 7, 1914.) 6 pp. Price, 5 cents.

S218. Comparison of the Silver and Iodine Voltameters and the Determination of the Value of the Faraday.....*G. W. Vinal and S. J. Bates*

Simultaneous measurements made with the silver and iodine voltameters have afforded a direct determination of the ratio of the silver deposit to the iodine deposit. The following results were obtained:

Ratio of silver to iodine.....	0.85017
Electrochemical equivalent of iodine	1.31502 mg per coulomb
Value of the Faraday (I=126.92)...	96,515 coulombs
Value of the Faraday (Ag=107.88).	96,494 coulombs

At the time of these experiments it was not known how great the error due to inclusions of foreign material in the silver deposits might be. It was assumed to be negligible. In S271 the inclusions have been determined to be 0.004 per cent of the deposit on the average. In S271 the above figures are revised and further discussed. (Jan. 2, 1914.) 26 pp. Price, 10 cents.

S219. Production of Temperature Uniformity in an Electric Furnace . . . . . *Arthur W. Gray*

After discussing some fundamental principles underlying temperature control, and reviewing previous attempts to secure temperature uniformity in electric furnaces, the paper outlines experiments that show how a double plug, conducting transversely while insulating longitudinally, has been used to reduce the temperature gradient in a column of heated air. It then describes the application of such a plug, combined with end-heating coils, to electric furnaces. The results obtained show that it is possible to heat a region of considerable length to any desired temperature up to about 700° C so uniformly that irregularities in the temperature distribution will be less than the effect of heterogeneity in thermoelements of the best quality, and probably less than the uncertainties at present existing in our knowledge of the temperature scale itself. (Feb. 3, 1914.) 23 pp. Price, 15 cents.

S220. The Silver Voltameter—Part IV. Third Series of Quantitative Experiments and Special Investigations . . . . . *E. B. Rosa, G. W. Vinal, and A. S. McDaniel*

Following the work of the international committee in 1910 the work on the silver voltameter was continued for the purpose of comparing the porous pot and the Smith forms of voltameters and to obtain such further data as were necessary for writing the specifications. The result of the third series of quantitative experiments is the value 1.01827 international volts for the Weston normal cell at 20° C. The relation between the acidity of the electrolyte (x) and the resulting decrease in deposit (y) in parts per million is found to be according to the equation $y = -4.5x + 0.02x^2$. The action of porous pots on silver nitrate and the conditions of reversibility of the voltameter were also investigated. [In S271 the values here found have been revised. See also S285.] (Dec. 1, 1913.) 62 pp. Price, 10 cents.

S221. Influence of Atmospheric Conditions in the Testing of Sugars . . . . . *Frederick Bates and Francis P. Phelps*

A simplified form of Marvin's evaporation equation has been applied to the evaporation of raw-sugar solutions during filtration. Marvin's formula reduces to $\frac{dQ}{dt} = C(P_s - P_a)$; $\frac{dQ}{dt}$ being the rate of evaporation; C, a constant for the particular case considered; $(P_s - P_a)$, the difference between the vapor pressure of the solution and the partial pressure of the water vapor already in the air. C has been evaluated by two different methods—(1) by weighing; (2) by polarization. Having determined C by the polarization method, it is then possible to compute a correction for evaporation to be applied to the polarization of a raw sugar under any known atmospheric condition. The calculated values of $\frac{dQ}{dt}$ agree satisfactorily with the observed values. (Feb. 1, 1914.) 19 pp. Price, 10 cents.

S222. Flame Standards in Photometry . . . . . *E. B. Rosa and E. C. Crittenden*

This paper gives results of experimental work with flame lamps of the types which have claims to consideration as primary standards of light, viz, the Carcel, the Hefner, and the Harcourt pentane lamp, with a general discussion of the defects and advantages of the several types. Effects of atmospheric conditions are discussed rather fully because some previously accepted correction factors were not in accord with the observed effects. In consistency of results obtained with a single lamp the pentane type is best, and hence is useful as a secondary standard, but ordinary pentane lamps differ considerably in candlepower. Hefner lamps have many faults, but different ones agree closely, giving this type an advantage as primary standards. By specifying construction and operation more exactly, it appears possible to obtain from either kind of lamp a useful check on our present electric reference standards. (Apr. 1, 1914.) 39 pp. Price, 10 cents.

S223. The Testing of Potentiometers . . . . . .
. . . . . *Frank Wenner and Ernest Weibel*

A theory is developed which explains the operation of the various kinds of potentiometers in use. This is then used in stating the corrections to a potentiometer and gives a direct indication of the measurements necessary to determine these corrections. Various methods which have been used to determine the corrections are given. A piece of apparatus designed especially for use in the calibration of potentiometers is described and the way in which it is used in the calibration of several of the common types of potentiometers is explained and illustrated. (June 10, 1914.) 40 pp. Price, 15 cents.

S224. The Emissivity of Metals and Oxides. I. Nickel Oxide (NiO) in the Range 600 to 1300° C
. . . . . *G. K. Burgess and P. D. Foote*

The monochromatic emissivity, E_λ, throughout the visible spectrum and the total emissivity, E, of nickel oxide (NiO) have been measured for the temperature interval 600° to 1300° C. The monochromatic emissivity increases linearly with increasing wave length and decreases linearly with increasing temperature over the region investigated. For example, at 1160° C, E_λ, increases from 0.86_5 at 0.5μ to 0.88_2 at 0.7μ, and for $\lambda=0.65\mu$, E_λ decreases from 0.95_8 at 800° C to 0.84_5 at 1300° C. The total emissivity increases with increasing temperature, but the relation is not linear. Temperatures and E have, respectively, values as follows: 600°, 0.54; 800°, 0.68; 1000°, 0.76; 1200°, 0.85; 1300°, 0.87. (Apr. 15, 1914.) 24 pp. Price, 10 cents.

S225. Adjustments of the Thomson Bridge in the Measurement of Very Low Resistances . . . . . .
. . . . . *Frank Wenner and Ernest Weibel*

The paper points out a difficulty in the accurate comparison of extremely low resistances by the Thomson-bridge method, if the desired adjustments are made in the usual way. This difficulty arises on account of the resistance of and the necessity for opening and closing the low-resistance connection between the resistances under comparison. Two procedures are given for making the desired adjustments, neither of which requires the opening and closing of this connection. (May 25, 1914.) 4 pp. Price, 5 cents.

S226. Quantitative Experiments in Radiotelegraphic Transmission . . . . . *L. W. Austin*

Experiments between Arlington and U. S. S. *Salem*, Colon, St. Augustine, etc. (Apr. 1, 1914.) 18 pp. Price, 5 cents.

S227. Measurements on Standards of Radiation in Absolute Value . . . . . *W. W. Coblentz*

In this paper is given the flux of radiant energy per square centimeter at a distance of 1 m from (1) the Hefner lamp, (2) the standard sperm candle, and (3) seasoned carbon incandescent lamps which were calibrated against a uniformly heated inclosure or so-called black body. These standards may be used in calibrating radiometers for absolute measurements. The flame standards are useful for approximate comparisons; but for precision work calibrated carbon incandescent lamps are recommended. In a supplementary note are some direct measurements in absolute value, including some preliminary values of the constant of total radiation. (June 24, 1914.) 14 pp. Price, 5 cents.

S228. An Experimental Study of the Koepsel Permeameter . . . . . *Charles W. Burrows*

This paper gives in detail the results of an experimental study of the possibilities and limitations of the Koepsel permeameter. Data are given to show the influence of the length, cross section, and material of the specimen, and other factors which may affect the accuracy of the readings. For small and moderate inductions the measured magnetizing force is usually in excess of its true value, sometimes by as much as 100 per cent, while at high inductions it is usually too low, sometimes by as much as 25 per cent.

However, with the use of proper correction curves, these errors will not exceed 5 per cent. Uncorrected hysteresis data for hard steels show values of the residual induction that are too small and of the coercive force that are too large by errors of 10 per cent and 40 per cent, respectively. The chief value of such an instrument is for comparative work in which it is desired to determine the degree of uniformity of material or the relative values of similar materials. (Aug. 1, 1914.) 20 pp. Price, 10 cents.

S229. Various Modifications of Bismuth-Silver Thermopiles Having a Continuous Absorbing Surface.....*W. W. Coblentz*

In this paper data are given on the radiation sensitivity of a thermopile as a function of the area exposed, the thermal conductivity and emissivity; also as a function of the external and internal resistance. Data are also given on the relative sensitivities of thermopiles of which one element is bismuth and the other element is either copper, iron, or bismuth alloys. A modification is given of the Angström pyrheliometer for measuring radiation in absolute value. A radiometer attachment to monochromatic illuminators is described, which is of importance to physiologists, psychologists, biologists, and physicists who are investigating the effect of light stimuli upon matter. Note 1 describes plane galvanometer mirrors of extreme lightness and note 2 describes experiments with a vacuum galvanometer. (Mar. 20, 1914.) 57 pp. Price, 20 cents.

S230. Combustion Calorimetry and the Heats of Combustion of Cane Sugar, Benzoic Acid, and Naphthalene.....*H. C. Dickinson*

Various factors, viz, temperature measurement, stirring, thermal conduction, convection, boundaries of the calorimeter, cooling corrections, and lag effects, affecting the accuracy of calorimeters are discussed, and some of the principles involved in the design of an accurate calorimeter are pointed out. An electrical method used in the calibration of bomb calorimeters is described and discussed. The results of an extended series of determinations of the heats of combustion of sucrose, benzoic acid, and naphthalene are tabulated and discussed. The paper also contains a partial bibliography of the subject. (July 16, 1914.) 69 pp. Price, 15 cents.

S231. Specific Heat of Copper in the Interval 0° to 50° C, with a Note on Vacuum-Jacketed Calorimeters.....*D. R. Harper 3d*

The specific heat of a specimen of copper 99.87 per cent pure was determined by a precise electrical method. The heat was supplied electrically and measured by potentiometer and clock; the temperature rise was measured by a resistance thermometer. "True specific heat," i. e., mean value over a short temperature interval (4° to 5°), was obtained. Apparatus, procedure, and results are fully described. A feature of the paper is a very complete review of all measurements of the specific heat of copper from the earliest to 1913. The use of a vacuum jacket as a means of reducing the cooling correction in calorimetry is discussed from the point of view of indicating the degree of exhaustion which it is profitable to attain with a fixed set of radiation conditions when thermal insulation by means of a vacuum jacket is sought. (May 30, 1914.) 71 pp. Price, 25 cents.

S232. Equilibrium in the System; Lead Acetate, Lead Oxide, Water at 25°.....*Richard F. Jackson*

Lead acetate, lead hydroxide, and water were mixed in varying proportions and the equilibria at 25° determined after several days' agitation. The solid phases capable of existence in equilibrium with aqueous solutions are as follows: The neutral acetate $Pb(C_2H_3O_2)_2.3H_2O$, which can exist in acid, neutral and slightly basic solutions, the tetralead monoxy-hexa-acetate $3Pb(C_2H_3O_2)_2PbO.3H_2O$, which possesses great solubility but depends for its existence in equilibrium upon an excess of dissolved basic lead; the trilead dioxy-diacetate, whose saturation curve indicates very high solubility in less basic solutions and slight solubility in more basic solutions; and lead hydroxide, which can exist in equilibrium with dilute basic lead acetate solutions. The equilibria of the chemical reactions are discussed. (Aug. 19, 1914.) 15 pp. Price, 5 cents.

S233. A Watthour Meter Method of Testing Instrument Transformers.....*P. G. Agnew*

The ratio and phase angle of instrument transformers may be determined by two similar watthour meters, either of the portable type or the house type having the disks graduated in 100 divisions. For voltage transformers, an auxiliary current is passed in series through the current coils of the two meters, and the voltage coils are then connected alternately to the two transformers. For current transformers, the connections are inverted. Ratios are obtained by working the meters at unity power factor and the phase angles from readings at low power factors. The accuracy obtainable is ample for commercial purposes. (July 18, 1914.) 11 pp. Price, 5 cents.

S234. Insulating Properties of Solid Dielectrics..*Harvey L. Curtis*

In this paper are treated two properties of insulators, viz, conduction through the material and leakage over the surface. The volume resistivity of a large number of materials is tabulated, and the results of studies upon the effect of temperature and of the magnitude and length of time of application of the voltage are stated. Curves are given showing the change of surface resistivity with atmospheric humidity for 75 different materials. For high humidities of the surrounding air, leakage over the surface is usually determined by the thickness and conductivity of the film of moisture. The effect of temperature and of exposure to light are also determined. (June 18, 1914.) 64 pp. Price, 15 cents.

S235. A Direct-Reading Instrument for Measuring the Logarithmic Decrement and Wave Length of Electromagnetic Waves.....*Frederick A. Kolster*

An instrument for facilitating the measurement of the logarithmic decrement of high-frequency oscillations, such as exist in the wave trains emitted from radio transmitting stations, is described. The instrument contains a variable condenser, the capacity of which varies in accordance with the law of geometric progression. The logarithmic decrement is read directly from a scale attached to this condenser, and the task of making observations and necessary calculations required by the Bjerknes formula is eliminated. The complete theory and design of the instrument are given as well as experimental data. The measurement of the logarithmic decrement at radio stations is important, since the United States laws governing radio communication specify, among other things, that the logarithmic decrement per complete oscillation in the wave trains emitted by the transmitter shall not exceed two-tenths. (Aug. 15, 1914.) 35 pp. Price, 10 cents.

S236. Electrical Resistance and Critical Ranges of Pure Iron.....*G. K. Burgess and I. N. Kellberg*

The electrical resistance of pure iron has been determined from 0° to 950° C. The critical range A2 is characterized by a reversible inflexion in the resistance temperature curve (or cusp in the curve of temperature coefficients) at 757° C. The Ac3 range is located above the Ar3 range, both beginning at 894° and each extending over a 25° C interval. There are no other critical ranges in iron between 0° and 950° C. (Aug. 21, 1914.) 14 pp. Price, 5 cents.

S237. Absorption, Reflection, and Dispersion Constants of Quartz.....*W. W. Coblentz*

This paper gives quantitative data on the absorption, reflection, and dispersion of quartz extending from the ultraviolet to 3μ in the infra-red. The data are to be used in determining spectral energy curves. Quartz begins to absorb heavily beyond 1.8μ in the infra-red; and tabulated data are given for eliminating this absorption in a quartz prism. (Dec. 9, 1913.) 11 pp. Price, 5 cents.

S238. Characteristic Equations of Tungsten Filament Lamps and Their Application in Heterochromatic Photometry..... .....*G. W. Middlekauff and J. F. Skogland*

Color difference is a source of considerable difficulty when comparing the candlepower of lamps not closely alike in color. A convenient method of avoiding this difficulty is by the use of color screens to bring the lamps to a color match; but the calibration of the screens must first be made. This paper describes a new method of eliminating color difference by the use of tungsten standardized lamps. These are adjusted to color match the lamps under test and the correction to apply to the standards is then computed by a formula developed by the authors, or derived directly from the printed tables which were computed by means of the formula. By the above method the photometric difficulties arising from color difference are dealt with, once for all in determining for tungsten lamps the characteristic relations from which the formula was derived, and all subsequent measurements are reduced to the photometry of lights of the same color. (Oct. 10, 1914.) 52 pp. Price, 15 cents.

S239. A Vibration Electrometer.....*Harvey L. Curtis*

In this paper is described a modification of the quadrant electrometer for use as a vibration instrument. The instrument is of such form that the capacities can be approximately computed. The mathematical theory of the instrument is developed and experimental data are given to show the agreement between theory and experiment. (Sept. 29, 1914.) 18 pp. Price, 10 cents.

S240. Studies on the Silver Voltameter..... .....*G. A. Hulett and G. W. Vinal*

A comparison has been made of the voltameter apparatus and methods in use at Princeton University with those of the Bureau. In a preliminary comparison important differences were found. The cause of these has been traced to the method of preparing the porous cups and to a hitherto unsuspected source of error in the method of washing the deposit. Evidence has been obtained of a galvanic action by which silver, in contact with platinum and immersed in distilled water, passes into solution and is thereby lost to the deposit. A comparison of the effect of porous cups of different makers has been made and also a further comparison of gold and platinum cathodes. [See also S285.] (July 1, 1914.) 18 pp. Price, 10 cents.

S241. A Wheatstone Bridge for Resistance Thermometry *C. W. Waidner, H. C. Dickinson, E. F. Mueller, and D. R. Harper 3d.*

The paper describes a high precision mercury contact bridge designed with especial reference to flexibility of use in measurements with resistance thermometers. Measurements by the Thomson double-bridge method are also provided for. Full details of design and construction are shown by photographs, supplemented by brief description in the text. Special features are the use of shunt dials for the 0.0001, 0.001, and 0.01 ohm decades, a new form of hermetically sealed coil, and complete oil immersion of contacts as well as coils in order to reduce thermoelectromotive forces. (Oct. 1, 1914.) 20 pp. Price, 20 cents.

S242. The Emissivity of Metals and Oxides. II. Measurements with the Micropyrometer..... .....*G. K. Burgess and R. G. Waltenberg*

Measurements of monochromatic emissivity for wave lengths of 0.65μ and 0.55μ have been taken with the micropyrometer of some 23 metals and 12 oxides in the solid and liquid states. For most metals there is no temperature-coefficient of emissivity; some show a marked and others a slight or no discontinuity in emissivity at the melting point. Palladium shows an undercooling radiation phenomenon and the discontinuity of platinum at M. P. would render the Violle unit of light uncertain. (Oct. 24, 1914.) 15 pp. Price, 5 cents.

S243. The Emissivity of Metals and Oxides. III. The Total Emissivity of Platinum and the Relation Between Total Emissivity and Resistivity.. . . . . *Paul D. Foote*

The theory of radiation from metals developed by Aschkinass has been extended and the following general equation has been derived for the total emissivity of a metal:

$$E=0.5736\sqrt{rT}-0.1769rT$$

where E is the total emissivity at the absolute temperature T and r the volume resistivity of the metal at this temperature. Experimental observations upon platinum obtained by the use of radiation pyrometers confirmed the above theoretical relation. A table of corrections is given for converting temperatures observed with a radiation pyrometer sighted upon platinum, to true temperatures. The following table represents the total emissivity of pure platinum as a function of the temperature:

°C	0	200	400	600	800	1000	1200	1400	1700
E	.030	.051	.070	.089	.108	.124	.140	.155	.175

(Jan. 30, 1915.) 6 pp. Price, 5 cents.

S244. A Comparison of Stellar Radiometers and Radiometric Measurements on 110 Stars...*W. W. Coblentz*

This paper gives quantitative data on an intercomparison of thermocouples and bolometers designed for measuring heat from stars. It was found that the thermocouples were the more sensitive. An improved method for maintaining a vacuum by means of calcium is described. The thermocouples were used in connection with a 3-foot mirror and measurements were made on 112 celestial objects. This includes measurements on the bright and the dark bands of Jupiter, Saturn's rings, etc. It was found that red stars emit about three times as much total radiation as do blue stars having the same photometric magnitude. Quantitative measurements were made on stars down to the 5.3th magnitude and high-grade qualitative measurements were made on stars down to the 6.66 magnitude. The transmission of stellar radiation through a cell of water was found. The measurements show that blue stars have from two to three times as much radiation in the visible spectrum as have red stars. An estimate of the total radiation from all stars was obtained. (Nov. 5, 1914.) 44 pp. Price, 15 cents.

S245. Temperature Coefficient of Magnetic Permeability Within the Working Range . . . . . *Raymond L. Sanford*

It is shown in this paper that the temperature coefficient of magnetic permeability is of such a magnitude that it can not be neglected in precision work and also that it varies through wide limits with different materials or the same material with different heat treatments. Temperature control offers the only means of avoiding errors due to change in temperature. (Jan. 30, 1915.) 10 pp. Price, 5 cents.

S246. Methods of Measuring the Inductances of Low-Resistance Standards. . . . . *Frank Wenner, Ernest Weibel, and F. B. Silsbee*

Two methods are described for measuring the inductance of a low "non-inductive" resistance standard. Either of these methods gives values which do not depend upon the calculation, from dimensions, of the inductance of some low-resistance standard. The experimental work described was done for the purpose of testing the practicability of the methods for use in measuring the residual inductances of low-resistance standards. Determinations were made of the inductances of standards having resistances of 0.01, 0.001, and 0.000337 ohm. (May 28, 1915.) 11 pp. Price, 5 cents.

S247. An Aneroid Calorimeter . . . . . .
. . . . . *H. C. Dickinson and N. S. Osborne*

An account is given of a calorimeter utilizing for equalization of temperature the thermal conductivity of a solid copper shell in connection with a built-in heating coil and a built-in platinum resistance thermometer. Details of the design, construction, and operation are described. Results of the standardization of the instrument are given and also results of experimental determinations of the specific heat of water in the interval from 0° C to +40° C. (July 26, 1915.) 26 pp. Price, 10 cents.

S248. Specific Heat and Heat of Fusion of Ice . . . . . .
. . . . . *H. C. Dickinson and N. S. Osborne*

An account is given of a series of experimental determinations of the specific heat of ice in the temperature range from −40° C to 0° C and of the heat of fusion of ice. The measurements were made by means of a calorimeter of aneroid type. The specific heat of four samples of ice, all of high but of different degrees of purity, was determined. By analysis of the results conclusions are drawn as to the specific heat and heat of fusion of pure ice. Total heat tables for ice are appended. (July 16, 1915.) 33 pp. Price, 10 cents.

S249. The Emissivity of Metals and Oxides. IV. Iron Oxide . . . . . *George K. Burgess and Paul D. Foote*

Iron oxide in the spectral region $\lambda=0.65\mu$ is almost black, having an emissivity varying from 0.98 to 0.92 in the range 800 to 1200° C. The corrections necessary to apply to the readings of an optical pyrometer in this temperature range vary from 0 to 10° C. The total emissivity of iron oxide increases from 0.85 at 500° C to 0.89 at 1200° C. The corrections necessary to apply to the readings of a radiation pyrometer in this temperature range vary from 30 to 50° C. The drop in temperature through the oxide layer formed on the iron is of considerable importance; the iron may be 100° hotter than the outside of the oxide at 1000 C. (June 24, 1915.) 7 pp. Price, 5 cents.

S250. Characteristics of Radiation Pyrometers . . . . . .
. . . . . *George K. Burgess and Paul D. Foote*

Contains a discussion of the principles of radiation pyrometry, descriptions of the usual types of radiation pyrometers, their calibration, errors, methods of use, and applications. (Aug. 10, 1915.) 88 pp. Price, 20 cents.

S251. Interference Measurements of Wave Lengths in the Iron Spectrum (2851–3701), with Notes on Comparisons of Lengths of Light Waves by Interference Methods, and Some Wave Lengths in the Spectrum of Neon Gas . . . . . .
. . . . . *Keivin Burns and W. F. Meggers*

One hundred and thirty-one lines were measured in the iron spectrum by means of the Fabry and Perot interferometer. The standard wave length was furnished by a Michelson H tube containing cadmium. The interferometer plates were coated with nickel. The lines were separated by means of a 21-foot Rowland grating mounted in parallel light. As far as possible both faint and strong lines were measured in all parts of the spectrum and lines were chosen at intervals of about 10 ångstroms.

The second part of the paper outlines a convenient method for correcting interference measurements for phase change. The method of determining the distance between the interferometer plates is also discussed. Provisional wave lengths of several neon lines are given. (July 15, 1915.) 27 pp. Price, 10 cents.

S252. Effective Resistance and Inductance of Iron and Bimetallic Wires.....*John M. Miller*

A method is developed for determining exact permeability curves for the circular magnetization which results when a current of electricity flows through an iron wire. Comparisons are made with permeability curves for axial magnetization. The effective resistance and inductance of copper-clad wires and iron telephone wires are measured with an Anderson bridge at frequencies up to 3000 cycles per second and current strengths up to 10 amperes. Formulas are developed for the calculation of the skin effect in bimetallic wires and comparisons made with measured values for copper-clad wire. A table gives computed values of effective resistance and inductance of copper-clad wires for the even sizes from No. 0 to No. 12 (A. W. G.) and 30, 40, and 50 per cent conductivities. (Aug. 3, 1915.) 61 pp. Price, 20 cents.

S253. A Direct-Reading Device for use in Computing Characteristics of Vacuum Tungsten Lamps.. .....*J. F. Skogland*

A computing device consisting of volt, watts per candle, and per cent candlepower scales is presented. This device is ready for use after detaching the volt scale. Settings of the volt scale to observed values within the range of from 0.70 to 2.05 wpc permit direct reading from the proper scales of any one of the variables at any point within this range.

Tables of values used in constructing this device and a full description of every point relating thereto, practical examples, and a brief mathematical discussion are presented in the paper. The chief merit of the device is a great saving of time with practically no sacrifice of precision. (July 31, 1915.) 20 pp. Price, 10 cents.

S254. A Study of the Quality of Platinum Ware..... .....*George K. Burgess and P. D. Sale*

Undertaken at the suggestion of a committee of the American Chemical Society. A thermoelectric method for determining platinum purity has been devised which does not mar the material tested, and applied to 164 samples. Methods for determining exactly losses in weight after acid treatment have been developed and applied to 14 crucibles of several degrees of purity. It is shown that losses in weight may be predicted from emf and microscopic examinations; the iron content is found not proportional to magnetic susceptibility; suggestions are offered concerning specifications for platinum crucibles; and nature of disintegration is briefly discussed. (Aug. 25, 1915.) 28 pp. Price, 10 cents.

S255. Calculation of the Maximum Force Between Two Coaxial Circular Currents.....*Frederick W. Grover*

In the absolute measurement of electric current it is important to so place the coils of the apparatus that the force exerted between these coils will be a maximum. In this paper two formulas have been developed which determine the distance between the coils corresponding to maximum force. This distance can be determined only by a series of approximations, but by the use of differential formulas the desired approximation is readily obtained. When the maximum distance has thus been obtained, it may be substituted in well-known formulas to obtain the maximum force. Numerous examples are given to show the application of the formula, and tables are compiled to facilitate their use. (Aug. 30, 1915.) 57 pp. Price, 15 cents.

S256. Construction of Primary Mercurial Resistance Standards..... .....*F. A. Wolff, M. P. Shoemaker, and C. A. Briggs*

The paper deals with the construction of four 1-ohm mercury standards of resistance in accordance with the specifications of the London Conference on Electrical Units and Standards (1908).

The tubes were selected, straightened, and graduated by Baudin in Paris and carefully calibrated at the Bureau of Standards. The ohm

lengths were then determined approximately, the tubes cut, and the ends optically polished.

Determinations of the L_0 of the finished tubes were made by direct comparisons with standard meter bars at 0°, and fillings for the determination of M_0 were made by the Reichsanstalt method.

The Thomson bridge method of electrical comparison was employed. The results obtained show the relative agreement of the four tubes to be very good, the average deviations of the individual tubes from their mean being ± 5 millionths of an ohm. (Oct. 9, 1915.) 90 pp. Price, 25 cents.

S257. Note on the Resistance of Radiotelegraphic Antennas.....*L. W. Austin*

It is well known that for the longer wave lengths most land radio stations show an increase in antenna resistance with increasing wave length, although the radiated energy decreases with the wave length. This phenomenon may be explained on the supposition that the antenna and ground water act as plates of a condenser. The earth above the ground water acts as a poor dielectric, the equivalent resistance of which is known to increase with the wave length. (Oct. 16, 1915.) 4 pp. Price, 5 cents.

S258. A Method of Measuring Earth Resistivity..*Frank Wenner*

The paper describes a method for measuring the effective resistivity for portions of earth which are large in comparison with samples which might be taken into the laboratory for test. By the method the resistivity may be found to a considerable depth without placing electrodes at corresponding depths and without disturbing the portion of earth to be tested. (Oct. 11, 1915.) 10 pp. Price, 5 cents.

S259. A New Relation Derived from Planck's Law.....
.....*Paul D. Foote*

The product of the absolute temperature and the λ—coordinate of the center of gravity of the spectral energy curve of a black body is a constant of the following value: $\theta\lambda_c=0.37021\ C_2$. (Dec. 3, 1915.) 4 pp. Price, 5 cents.

S260. "Center of Gravity" and "Effective Wave Length" of Transmission of Pyrometer Color Screens, and the Extrapolation of the High Temperature Scale.....*Paul D. Foote*

A new method for determining the "effective wave length" of the color and absorption screens used in optical pyrometry is derived and applied to several specific screens and glasses. The shift of effective wave length with change in temperature of the source and the effect this shift may have upon the accuracy of temperature measurements are discussed. It is shown both theoretically and experimentally that for precise work at high temperatures with pyrometers using color screens a thorough knowledge of the change of the effective wave length with temperature is required. (Mar. 13, 1916.) 19 pp. Price, 10 cents.

S261. Studies of Instruments for Measuring Radiant Energy in Absolute Value: An Absolute Thermopile.....*W. W. Coblentz and W. B. Emerson*

This paper gives the results of an investigation of a radiometer, consisting of a thin blackened strip of metal with a thermopile back of it, for measuring radiant energy in absolute units. The strip of metal functions (1) as a receiver for absorbing radiant energy, (2) as a source of radiation (by heating it electrically) which may be evaluated in absolute measure, and (3) as a standard source of radiation for testing the sensitivity of the radiometer, which includes both galvanometer and thermopile. The effect produced by varying the width and the thickness of the strip was investigated and the loss of energy was found to be satisfactory for refined radiometric measurements. (Mar. 4, 1916.) 49 pp. Price, 15 cents.

S262. Present Status of the Determination of the Constant of Total Radiation from a Black Body
. . . . . *W. W. Coblentz*

In this paper are given the results of an inquiry into the probable value of the constant of total radiation as determined by different observers. It is shown that all these determinations cluster closely about the mean value of $\sigma=57$. Experimental data are given on the lack of blackness of the radiator, on the absorption by atmospheric water vapor, etc. The data obtained in a preceding paper are corrected for diffuse reflection. The mean value of 304 sets of measurements gives for the coefficient of total radiation of a uniformly heated inclosure or so-called black body, a value of $=5.72 \times 10^{-12}$ watt cm^{-2} deg^{-4} or 1.37×10^{-12} gr-cal cm^{-2} deg^{-4}. (Feb. 25, 1916.) 30 pp. Price, 10 cents.

S263. Illumination from a Radiating Disk . . . . . *Paul D. Foote*

A complete solution is given for the illumination produced by a diffusely and uniformly radiating circular disk at any point in space on a surface parallel to the disk. The correct solution is shown to be just as convenient to use as many of the approximate solutions appearing in the technical journals. (Mar. 13, 1916.) 4 pp. Price, 5 cents.

S264. Photometry of the Gas-Filled Lamp . . . . . .
. . . . . *G. W. Middlekauff and J. F. Skogland*

The gas-filled lamp introduces variables not hitherto met with in the photometry of incandescent lamps. It is found that both current and candlepower have different values at constant voltage when the lamp is rotating than when it is stationary. Also for any change in speed there is a corresponding change in current in one direction and in candlepower in the opposite direction. Furthermore, the direction of these changes depends upon whether the speed is above or below a certain value. From the standpoint of photometry it is fortunate that at this particular speed both current and candlepower at constant voltage have the same values as when the lamp is stationary. Hence, by rotating the lamp at that speed the mean horizontal candlepower may be determined without introducing errors caused by rotation. (Mar. 16, 1916.) 18 pp. Price, 10 cents.

S265. Life Testing of Incandescent Lamps at the Bureau of Standards . . . . . .
. . *G. W. Middlekauff, B. Mulligan, and J. F. Skogland*

The method employed by the Bureau of Standards in the inspection and life testing of incandescent lamps for the Federal Government is outlined and a description of the power plant, the life racks, and the photometer is given. Particular attention is directed to the special equipment of the photometer. This includes a watts-per-candle computer and a recording device by which observed values of candlepower, watts, watts-per-candle, and actual life are recorded on a separate card for each lamp. These records are made in such a way that life at forced efficiency is corrected to life at normal without computation or reference to tables of factors. The procedure in actual measurement and testing is described with considerable detail. (Mar. 16, 1916.) 26 pp. Price, 10 cents.

S266. Preparation of Pure Iron and Iron-Carbon Alloys
. . . . . *J. R. Cain, E. Schramm, and H. E. Cleaves.*

Previous work on the iron-carbon thermal diagram is incomplete or is unsatisfactory because of impurities in the alloys used, hence the present series of alloys having a purity of 99.96 per cent was made up at the Bureau as a preliminary to a reinvestigation of the subject. The iron was prepared electrolytically from a chloride electrolyte using commercially pure ingot iron anodes; the carbon was made from pure sugar. The melting was done in a vacuum furnace in crucibles made from specially purified magnesia prepared by a method described in the paper. (Feb. 29, 1916.) 26 pp. Price, 10 cents.

S267. Colorimetric Determination of Acetylene and Its Application to the Determination of Water ..... *E. R. Weaver*

This paper combines the article on "A qualitative test for water by the use of the acetylene-cuprous chloride reaction" with the paper on the "Colorimetric determination of acetylene," both published in the Journal of the American Chemical Society. Some rearrangement and condensation have been necessary, otherwise the two former papers are followed closely. (Feb. 29, 1916.) 39 pp. Price, 15 cents.

S268. Constants of the Quartz-Wedge Saccharimeter and the Specific Rotation of Sucrose. I. The Constants for the 26-Gram Normal Weight ..... *Frederick Bates and Richard F. Jackson*

The accepted basis of standardization for the saccharimeter is that known as the Herzfeld-Schönrock determination of the 100° sugar point. This is predicated on the so-called conversion factor or normal quartz-plate rotation for sodium light, which they found to be 34°.657. In the present research sucrose was prepared by concentrating the sirup in a vacuum boiling apparatus at about 35° C and crystallizing in motion. The questions of caramelization and elimination of reducing sugars and water were carefully studied. Approximately normal solutions were prepared and the rotations measured on both polarimeter and saccharimeters under conditions favorable to high precision. The reading of the normal sugar solution on the saccharimeter is found to be 99°.895 S instead of 100° S. The Herzfeld-Schönrock scale is, therefore, concluded to be in error by over 0°.1 S. The new conversion factors are found to be 40°.690 for λ=5461.A and 34°.620 for λ=5892.5A and the rotations of the normal solution are 40°.763 and 34°.517, respectively, for these wave lengths. For the specific rotations the following are obtained

$$\left[\alpha\right]^{20}_{\lambda=5892.5A}=66°.529$$

$$\left[\alpha\right]^{20}_{\lambda=456}=78°.342.$$

The values of a number of additional constants have also been given (Apr. 6, 1916.) 62 pp. Price, 15 cents.

S269. Effect of Imperfect Dielectrics in the Field of a Radiotelegraphic Antenna ..... *John M. Miller*

It is shown by measurements at telephone and wireless frequencies that the linear rise in resistance of an antenna with increasing wave length, which takes place at the longer wave lengths, is caused by absorption in the antenna, acting as a condenser, as advanced by Austin. The phenomenon, however, is not due to the ground but to the presence of absorbing dielectrics in the field of the antenna, such as wooden masts, trees, insulation, buildings, etc. The importance of reducing this absorption to a minimum in the design of an antenna is pointed out. (Mar. 20, 1916.) 8 pp. Price, 5 cents.

S270. Luminosity of a Black Body and Temperature... ..... *Paul D. Foote and C. O. Fairchild*

The relation between luminosity of a black body and temperature has been derived by a new method. The Rasch equation is shown to be unsatisfactory, while the Nutting equation or a slight modification of the Nutting equation holds exceedingly well. The exact meaning of the Crova wave length is defined and is shown to be of the form

$$\lambda_L=a+b/\theta+c/\theta^2$$

(Mar. 21, 1916.) 9 pp. Price, 5 cents.

S271. Inclusions in the Silver Voltameter Deposits..... .....*G. W. Vinal and William M. Bovard*

Silver voltameter deposits have been heated to 600° C and over to expel the small amounts of inclusions of foreign material that they contain. On the average, these are found to be 0.004 per cent of the deposit. In using this method a serious source of error arises from the alloying of the platinum and the silver. Means of avoiding this error are indicated. The value for the absolute electrochemical equivalent of silver given in S220 is revised. It is found to be 1.11800 mg per coulomb. The value for the Faraday (S218) is further discussed. (See also S285.) (Mar. 24, 1916.) 26 pp. Price, 5 cents.

S272. Correlation of the Magnetic and Mechanical Properties of Steel .....*Charles W. Burrows*

This paper is a review of the work done in correlating the magnetic and mechanical properties of steel with special reference to the commercial application of the magnetic data as criteria of the mechanical fitness of a given steel and of magnetic changes of steel under stress as indications of the state of strain. The evidence presented shows that the interrelation of magnetic characteristics and the mechanical behavior of steel is so close that the magnetic examination in conjunction with the mechanical tests may be expected to add considerably to our knowledge of the material.

The magnetic method tests the whole amount of material and not merely some surface layer. It does not destroy the test piece, but leaves it unaltered, so that it is possible to apply a magnetic test to the identical material that is to enter into a given structure. (Mar. 29, 1916.) 38 pp. Price, 15 cents.

S273. General Design of Critically Damped Galvanometers.....*Frank Wenner*

The relations between the operating constants (sensitivity, period, etc.) with which the user of the galvanometer is concerned and the intrinsic or construction constants with which the designer and builder of the galvanometer are concerned are given. These relations are then used in establishing a procedure for the design of galvanometers to have specified values for their operating constants. This is done for each of four sets of operating constants corresponding to the four classes of work in which galvanometers are used critically damped. (Apr. 12, 1916.) 34 pp. Price, 10 cents.

S274. Interference Measurements of Wave Lengths in the Iron Spectrum (3233A–6750A)..... ..*Keivin Burns, W. F. Meggers, and Paul W. Merrill*

The wave lengths of 403 iron lines were measured by means of interferometers. Faint as well as strong lines were measured at intervals of about 10 angstroms throughout the greater part of the spectrum from 3233A to 6750A. They constitute a satisfactory group of standards in this region. The mean difference between these observations and the international standards is about 1 part in 4 000 000.

Over 600 lines, including those measured, were examined by means of three or more interferometers in order to determine their sharpness. The relation of sharpness to intensity, pole effect, and behavior under pressure was sought from this data. In general, faint lines are sharpest. Change of wave length from the center of the arc to the poles, and by pressure, is more common with broad lines. (Apr. 11, 1916.) 28 pp. Price, 10 cents.

S275. Relation Between Composition and Density of Aqueous Solutions of Copper Sulphate and Sulphuric Acid.....*H. D. Holler and E. L. Peffer*

The densities of solutions of copper sulphate and sulphuric acid varying in concentration from 0 to 20 per cent of each solute were determined at 25° and 40° C. From the results obtained a simple method may be devised for determining and adjusting the composition of such solutions. (Apr. 7, 1916.) 9 pp. Price, 5 cents.

S276. Protected Thermoelements . . . . . *Arthur W. Gray*

The paper describes a mounting for protecting laboratory thermoelements from damage by contamination or by mechanical strains. It is easy to construct, convenient to use, and applicable to elements for either high or low temperatures. It may also be used with multiple thermoelements divided into two equal portions for the purpose of checking. The mounting, which includes the ice bottle, was at one time the type used in expansion determinations at the Bureau of Standards. (May 10, 1916.) 3 pp. Price, 5 cents.

S277. An Interlaboratory Photometric Comparison of Glass Screens and of Tungsten Lamps, Involving Color Differences . . . . . *G. W. Middlekauff and J. F. Skogland*

A report is given of a comparison of interlaboratory photometric measurements involving a considerable difference in color. The results are of value in showing the agreement which is to be expected between the results of groups of experienced observers working by different methods and with different kinds of photometers. The characteristics of those engaged in photometric work at the Bureau of Standards are discussed, and there is obtained additional evidence of the accuracy of the values assigned to the Bureau's 1.5-wpc tungsten standards, which had previously been verified in an intercomparison with the National Physical Laboratory of England. (June 17, 1916.) 21 pp. Price, 10 cents.

S278. An Investigation of the Laws of Plastic Flow . . . . . *Eugene C. Bingham*

A means is worked out for distinguishing sharply between a viscous and a plastic substance. The laws of plastic flow are discovered. The two quantities "friction" and "mobility," as applied to plastic flow, are defined and calculated for the mixtures used. It is shown how the plasticity of a material depends upon the fineness of grain of the solid. (June 5, 1916.) 45 pp. Price, 10 cents.

S279. Distribution of Energy in the Visible Spectrum of an Acetylene Flame . . . . . *W. W. Coblentz and W. B. Emerson*

The distribution of energy in the visible spectrum of a cylindrical acetylene flame was investigated by means of three types of spectroradiometers. The data were found in excellent agreement, and they are presented for publication to supersede similar data published some years ago. The latter data pertained to a flat acetylene flame, which the recent investigation shows to be lacking in sufficient reproducibility to be considered as a standard source of spectral energy. (May 29, 1916.) 10 pp. Price, 5 cents.

S280. Further Experiments on the Volatilization of Platinum . . . . . *G. K. Burgess and R. G. Waltenberg*

In this paper are given the results of an investigation, made at the suggestion of a committee of the American Chemical Society, on the loss in weight on heating of platinum crucibles of various makes and degrees of purity. The results obtained should prove of considerable value to the analytical chemist in aiding him to eliminate a troublesome source of error. It is shown that all grades of platinum contain at least traces of iron, that there is no appreciable loss in weight of crucibles heated to 900° C, but that above this temperature the loss increases very rapidly with temperature, is greatest for platinum containing iridium, and least for platinum alloyed with rhodium. (June 16, 1916.) 9 pp. Price, 5 cents.

S281. A Study of the Inductance of Four-Terminal Resistance Standards.....*Francis B. Silsbee*

A description of methods of measuring the inductance of resistance standards in the range below 1 ohm, with measurements on various types of standard now in use and suggestions as to the design of low-resistance standards of negligible inductance. The paper also contains a discussion of the errors in phase angle of mutual inductors of large current capacity. (July 12, 1916.) 48 pp. Price, 15 cents.

S282. Sensitivity and Magnetic Shielding Tests of a Thomson Galvanometer for use in Radiometry.....*W. W. Coblentz*

In this paper are given the results of an investigation of the force exerted by various galvanometer coils when operated under standard conditions. Numerical data are given relating to coils wound in sections of graded wire. A coil is described wound with a single kind of wire, which was found to be very efficient. A comparison is made of various astatic magnet systems, and data are given showing the importance of using small mirrors in order to increase the sensitivity.

Experimental data are given on shielding the galvanometer needle from external magnetic disturbances. By imbedding the coils in blocks of Swedish iron and surrounding this support with cylindrical shells of wrought-iron pipe the effect of external magnetic perturbations upon the astatic needle system is easily reduced to 1/2000 of its original value. Note I is a discussion of vacuum thermopiles. (June 30, 1916.) 24 pp. Price, 10 cents.

S283. Volume Effect in the Silver Voltameter.....*E. B. Rosa and G. W. Vinal*

The volume effect consists in an excess weight of deposit in the large-size voltameters over that in the smaller sizes and it is due to the presence of certain impurities in the electrolyte. An analysis of earlier experiments, together with a few recently made, is given in the present paper. The results show that the volume effect is not confined to any one form of voltameter but is common to all forms. The volume effect may be eliminated by purifying the electrolyte or it may be greatly exaggerated by adding impurities to the electrolyte. A theory to account for the manner in which the impurities increase the weight of the deposited silver is given. [See also S285.] (July 10, 1916.) 11 pp. Price, 5 cents.

S284. Constants of Spectral Radiation of a Uniformly Heated Inclosure or So-Called Black Body, II.....*W. W. Coblentz*

The present paper gives the results of a recomputation of the data published in a previous paper (S204). This recomputation was necessitated as the result of the adoption of a new calibration curve of the fluorite prism used in obtaining the data. The new value of the constant is C=14 353, which is about 0.7 per cent lower than the value previously published. The new value is very close to the theoretical value as obtained from a consideration of the coefficient of total radiation recently published in this Bulletin (S262). (July 8, 1916.) 19 pp. Price, 10 cents.

S285. Summary of Experiments on the Silver Voltameter at the Bureau of Standards and Proposed Specifications .....*E. B. Rosa and G. W. Vinal*

The investigations of the silver voltameter made in the Bureau of Standards between 1908 and 1916 have been published in eight separate papers. The present paper contains a summary of these eight papers and specifications for the use of the silver voltameter. These specifications, which are the practical result of seven out of the eight preceding papers, are put forward as the Bureau's proposals for international adoption. A bibliography of papers dealing with the silver voltameter is given as an appendix, and a list of corrections (mostly typographical) to the eight papers preceding this is given as a second appendix. (Oct. 5, 1916.) 36 pp. Price, 15 cents.

S286. Determination of Aluminum as Oxide . . . . . *William Blum*

From observations made with a hydrogen electrode and with suitable indicators, the conditions for the quantitative precipitation of aluminum hydroxide by ammonium hydroxide were determined. In practice the completion of precipitation may be defined by means of methyl red or of rosolic acid. The effect of various factors upon the precipitation, washing, and ignition of the precipitate was determined. The procedure for obtaining accurate results is also described. (Aug. 10, 1916.) 20 pp. Price, 10 cents.

S287. Calculation of Planck's Constant c_2. . . . . *J. H. Dellinger*

This constant, which is of great importance in high-temperature measurements, has heretofore been obtained from radiation data by processes involving the use of a graph. It may be very easily determined directly from any two observations, the formula being scarcely more complicated than the familiar one for equal ordinates. All graphical difficulties are eliminated, and the method is not limited by experimental conditions such as absorption bands. The power of the method in investigating the departure of observations from the Planck law is strikingly shown by application to experimental data. Calculations made from observations all on one side of the maximum gave abnormally high values of c_2. The same method of calculation is applicable to the determination of the maximum and other points of the isothermal curve for which the displacement law holds. (Aug. 16, 1916.) 11 pp. Price, 5 cents.

S288. Wheatstone Bridges and Some Accessory Apparatus for Resistance Thermometry . . . . . *E. F. Mueller*

Simple types of Wheatstone bridges are described in which by suitable arrangement of circuits the degree of accuracy formerly attained by the use of mercury contacts may be secured by the use of plugs or switches. A method of measuring potential terminal resistances with the Wheatstone bridge is described and also an interchanger for connecting several thermometers to a single bridge. (Oct. 23, 1916.) 15 pp. Price, 10 cents.

S289. The Damping of Waves and Other Disturbances in Mercury . . . . . *M. H. Stillman*

The paper describes an electromagnetic method of damping the large oscillations of a mass of mercury and also the smaller waves and ripples which result from the movements of the support of the vessel containing the mercury. Experiments illustrating the method are described. (Sept. 30, 1916.) 6 pp. Price, 5 cents.

S290. A Variable Self and Mutual Inductor . . . . . *H. B. Brooks and F. C. Weaver*

The development of a new form of variable inductor is outlined. This instrument was required in the testing of current transformers, but is applicable wherever it is necessary to vary the self-inductance of a circuit or the mutual inductance between two circuits. It consists of two pairs of fixed coils held in ebonite disks between which rotates a third disk carrying a pair of coils. The form and arrangement of the coils are such as to give the instrument the following advantages: (1) High time constant; (2) scale divisions of uniform length; (3) astaticism. Curves are given showing the performance of the new instrument and of other instruments for the same purpose. Data are given for the design of inductors of the new form. (Oct. 12, 1916.) 12 pp. Price, 10 cents.

S291. A System of Remote Control for an Electric Testing Laboratory . . . . . *P. G. Agnew, W. H. Stannard, and J. L. Fearing*

The system described gives complete control of a group of motor-generator sets in several laboratory rooms, so that in testing a wattmeter, for example, a small multiple-lever controller gives both coarse and fine adjustment of frequency, current, voltage, power factor, and an auxiliary direct-current voltage. The field rheostats are very long slide-wire motor-operated

rheostats, motor-operated by means of pulley and cord. A large, motor-operated, low-voltage rheostat for currents up to 10 000 or 12 000 amperes is included in the system. In the latter, laminated brushes bear directly on water-cooled resistance tubes. (Oct. 12, 1916.) 17 pp. Price, 10 cents.

S292. International System of Electric and Magnetic Units . . . . . *J. H. Dellinger*

The international electric and magnetic units, while representing the electromagnetic units, may be looked upon as a distinct and complete system, differing dimensionally from the electrostatic and electromagnetic systems. They are the units actually used in electrical work. The dimensional expressions in the international system are particularly simple. The ampere-turn is the basis of a set of magnetic units which are shown to be "rationalized" in a surprisingly satisfactory manner. The nomenclature of magnetic units is discussed. (Oct. 11, 1916.) 33 pp. Price, 10 cents.

S293. The Saccharimetric Normal Weight and Specific Rotation of Dextrose . . . . . *Richard F. Jackson*

Dextrose is purified by repeated crystallization from aqueous solution, a portion being many times fractionated. It loses its water of crystallization at 60° C and its residual moisture in a vacuum at 60° to 80°. The densities of dextrose solutions are indicated by the formula: $D_{4^\circ}^{20^\circ} = 0.99840 + 0.003788\ p + 0.00001412\ p^2$ where p is per cent by weight in vacuo. The weight required to rotate 100 S on the saccharimeter is 32.231 g. The photometric field is slightly heterochromatic. At lower concentrations a table gives the corrections for deviation from proportionality. The rotation of the normal solution for $\lambda = 5461$ A is 40°.897. The specific rotation varies with concentration according to the formula $[\alpha]_{5461A}^{20.0} = 62.032 + 0.04257\ c$ where c is grams of anhydrous dextrose in vacuo and contained in 100 cc of solution. (Oct. 27, 1916.) 21 pp. Price, 10 cents.

S294. Freezing Point of Mercury . . . . . *R. M. Wilhelm*

The temperature of the freezing point of mercury was determined, using three platinum resistance thermometers. Nineteen determinations were made on three samples of mercury purified by different methods. The result of all the measurements gives −38°.873 for the freezing point. The maximum deviation of any determination from the mean is 0°.005. (Oct. 26, 1916.) 7 pp. Price, 5 cents.

S295. Determination of the Degree of Uniformity of Bars for Magnetic Standards . . . . *Raymond L. Sanford*

Magnetic standard bars are used for the calibration of permeameters and the comparison of methods of magnetic testing with a standard method. One requisite of a magnetic standard bar is that it shall be magnetically uniform along its length. If this condition is not met, errors may arise which can not be calculated or eliminated from the measurements and which may be of considerable magnitude. This paper (1) describes a method for determining the degree of magnetic uniformity of straight bars, (2) indicates the magnitude of the effect of nonuniformities on the accuracy of magnetic measurements, and (3) gives a criterion for the degree of uniformity of bars for magnetic standards. (Nov. 21, 1916.) 14 pp. Price, 10 cents.

S296. Thermoelectric Measurement of Critical Ranges of Pure Iron . . . . . *George K. Burgess and H. Scott*

Adapting the apparatus described in S213, a new method of determining thermoelectric power directly in terms of temperature has been devised and applied to the couple iron platinum, using metals of highest purity in vacuo over the range 0 to 1000° C. The thermoelectric characteristics of the critical points A_2 and A_3 are also demonstrated. (Nov. 22, 1916.) 7 pp. Price, 5 cents.

S297. A Study of Electromagnet Moving Coil Galvanometers for Use in Alternating-Current Measurements.....*Ernest Weibel*

The theory of the electromagnet moving coil galvanometer is given and is used to determine the performance and proper design of such instruments. The paper contains descriptions of the construction and performance of several instruments on direct current and on alternating currents of frequencies up to 2100 cycles per second. The sensitivities and other operating constants are comparable with those of the best permanent-magnet moving coil galvanometers for direct-current measurements. (Feb. 17, 1917.) 36 pp. Price, 10 cents.

S298. Standard Substances for the Calibration of Viscometers....*Eugene C. Bingham and Richard F. Jackson*

The viscosities of 20, 40, and 60 per cent sucrose solutions have been determined over a wide range of temperatures. The available data on the viscosity of water, ethyl alcohol-water mixtures, and sucrose solutions have been reviewed in view of their possible use for comparative purposes. The use of the centipoise, as a practical unit of viscosity, has been suggested. (Mar. 19, 1917.) 28 pp. Price, 5 cents.

S299. An "Average Eye" for Heterochromatic Photometry, and Comparison of a Flicker and an Equality-of-Brightness Photometer.....
.....*E. C. Crittenden and R. K. Richtmyer*

Comparisons of lights of different colors are supposed to be based on "the average normal eye." This paper records an attempt to approximate the results of such an eye on typical color differences by using a large number of observers. In particular, results obtained by a flicker photometer and by an equality-of-brightness photometer, with different degrees of color differences, are compared. (May 26, 1917.) 29 pp. Price, 5 cents.

S300. Emissivity of Straight and Helical Filaments of Tungsten.....*W. W. Coblentz*

In this paper data are given on the radiation from the inside and the outside of the turn of a helically wound tungsten filament in an atmosphere of nitrogen. The intensity of the light from within the helix is 90 per cent greater than from the outside of the turn. This is accounted for on the basis of multiple reflection within the helix, which modifies the quality of the light so that it appears redder than the light from the outside of the turn. The observed infra-red measurements on the radiation from within the helix and the computed values are in agreement, showing that the increased brightness is due to internal reflection. Polarization measurements show that the light is highly polarized and hence not comparable with the radiation from a black body. The character of the radiation from within the helix are not sufficiently close to black-body radiation to permit the use of the filament as a means of determining temperatures. (June 8, 1917.) 79 pp. Price, 5 cents.

S301. Aneroid Calorimeter for Specific and Latent Heats.....*N. S. Osborne*

The unstirred type of calorimeter has been embodied with important refinements in an instrument specially designed for determination of specific heat and latent heat of refrigerating media. Heat developed and measured electrically is distributed automatically to the calorimeter and contents whose temperatures are measured by a platinum thermometer. Heat from other sources is excluded by a null method.

The calorimeter is adapted for use between $-50°$ and $+50°$ C in experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapor; in the first case the specific heat of the liquid and in the second the latent heat of vaporization being obtained when proper corrections are made. (June 8, 1917.) 27 pp. Price, 10 cents.

S302. Wave Lengths of Stronger Lines in Helium Spectrum . . . . . *P. W. Merrill*

Wave lengths of 21 of the stronger helium lines have been measured by means of Fabry and Perot interferometer of different separations to an accuracy approaching 0.001A. Nine of them were compared directly with the standard cadmium line. The helium lines will thus become available as convenient standards for the determination of other wave lengths. The precision previously attained was insufficient for many uses.

The possibility of eliminating effects of the so-called "phase change" at reflection from the interferometer minors is noted.

The Kayser and Runge formula for spectral series with constants derived from three consecutive lines will not reproduce accurately even the next member in any one of the six series. (June 18, 1917.) 8 pp. Price, 5 cents.

S303. Relative Sensibility of Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems . . . . . *W. W. Coblentz and W. B. Emerson*

This paper gives data on the relative visibility of radiation of the average eye based upon a group of 130 observers. The data were obtained by means of a flicker and an equality-of-brightness photometer. The energy evaluation of the light stimulus was made with great care.

The point of maximum visibility of the average eye is at $\pm 0.5576\mu$. A mathematical equation is given of the average visibility curve, which is applied in a subsequent paper in calculating the luminous energy emitted by a black body at various temperatures and the mechanical equivalent of light. The eye responds to light having an intensity less than 1×10^{-16} watt. The paper describes tests on diffuse light and on a physical photometer. A screen is described which transmits radiations proportional to the average eye. (June 29, 1917.) 77 pp. Price, 15 cents.

S304. Calculations of Constants of Planck's Radiation Equation: Application of Theory of Least Squares . . . . . *Harry M. Roeser*

The problem of computing the constants c_1 and c_2 of Planck's radiation equation for the distribution of energy in the spectrum of a black body,

$$E = c_1 \lambda^{-5} \left(e^{\frac{c_2}{\lambda \theta}} - 1 \right)^{-1}$$

is attacked for the first time by the method of least squares. The rationale of the method is given and an outline of the computations stated. The theory of errors is applied to show that current methods of solution have not agreed because a system of weighting inherent in the manipulation of the observations has previously been neglected, and further, this system of weights being applied, the solutions tend to agree with that of least squares. (June 29, 1917.) 18 pp. Price, 5 cents.

S305. Luminous Radiation from a Black Body and Mechanical Equivalent of Light . . . . . *W. W. Coblentz and W. B. Emerson*

This paper gives applications of the curve of visibility of radiation for the average eye (see S 303) to radiation problems, including the luminous intensity of a black body at various temperatures, the luminous efficiency, and the mechanical equivalent of light. The data at hand indicate that 1 watt of radiant power of maximum visibility amounts to about 50 candles. The paper gives also a determination of the radiant luminous efficiency of a vacuum tungsten lamp. (June 30, 1917.) 12 pp. Price, 5 cents.

S306. An Experimental Study of the Fahy Permeameter. . . . . .*Charles W. Burrows and Raymond L. Sanford*

This paper presents the results of a critical experimental study of the Fahy permeameter. The accuracy of normal induction measurements on solid materials is within 5 per cent of the magnetizing force required for a given induction. Hysteresis measurements are accurate within the limits of commercial requirements and the uniformity of commercial materials. (Aug. 27, 1917.) 34 pp. Price, 10 cents.

S307. Note on Electrical Conduction in Metals at Low Temperatures. . . . . *Francis B. Silsbee*

Measurements at the University of Leiden have shown that at extremely low temperatures certain metals show an enormously high electrical conductivity. This superconducting state ceases to exist and ordinary resistance appears if either the current used to measure the resistivity, or the magnetic field in which the metal is placed, is increased above a certain critical value. This paper points out that these two phenomena are not independent, but that the former effect is a necessary consequence of the existence of the latter; that is, the threshold value of current is that at which the magnetic field due to the current itself is equal to the critical magnetic field. The experimental evidence available is in agreement with this relation. (July 23, 1917.) 6 pp. Price, 5 cents.

S308. The Reflecting Power of Tungsten and Stellite. . . . . .*W. W. Coblentz and W. B. Emerson*

The reflecting power of tungsten in the region of the spectrum from 0.5 to 6 was determined by comparison with silver and by a new method employing a total reflection prism. Four samples in the form of plane, highly polished mirrors were examined. All the samples showed a depression in the reflecting curve at 0.8μ. A similar indentation occurs at 1.3 in the reflecting curve of the pure metal but not in the impure tungsten. The bands of selective reflection at 0.8μ and 1.3μ render tungsten conspicuous as being the only metal, thus far investigated, which has bands of selective reflection in the infra-red. The application of these data to the question of increasing the luminous efficiency of incandescent lamps is discussed.

The reflectivity of stellite is similar to that of other metals; being low in the visible spectrum and increasing to high values in the infra-red. (Aug. 10, 1917.) 20 pp. Price, 5 cents.

S309. A Method for Testing Current Transformers. . . . . .*Francis B. Silsbee*

A general method is described for comparing the ratio and phase angle of one current transformer with those of a previously tested transformer of the same nominal ratio. The two transformers are corrected in series on both primary and secondary and a shunt circuit is provided to measure the difference of the secondary currents. Two of the many possible arrangements are described in detail. This method is intended for use under shop conditions and does not require the use of sensitive apparatus. (Nov. 3, 1917.) 13 pp. Price, 5 cents.

S310. Some Electrical Properties of Silver Sulphide. . . . . .*George W. Vinal*

Silver sulphide may be prepared in the form of short wires or thin strips like a metal. The wire, which must be drawn hot, was found to conduct electricity like a metal of high specific resistance and practically zero temperature coefficient. The strip of sulphide rolled at room temperature has a large temperature coefficient and shows both metallic and electrolytic conduction. It has a volt-ampere curve characteristic of a pyroelectric conductor. The strips are sensitive to small alternating currents which increase the resistance enormously, while small direct currents have the opposite effect. The specific resistance has been measured and experiments made on the electrochemical decomposition. (Nov. 24, 1917.) 9 pp. Price, 5 cents.

S311. Axial Aberrations of Lenses. . *E. D. Tillyer and H. I. Shultz*

The errors which affect the definition of a lens are discussed and methods of graphically representing the central errors described. The condition for freedom from coma near the axis is arrived at. The relative importance of the errors in different types of lenses is discussed. Hartmann's method is expanded, permitting one set of measurements to give all the important central errors—spherical aberration, zonal variation of equivalent focal length, axial and oblique achromatism. The apparatus and procedure are described, and the accuracy of the adjustments and the measurements discussed. The method is applicable to all systems of relatively short focus and large aperture, such as photographic lenses, projection lenses, and telescope objectives, and also to complete optical systems. The results of the method as applied to a complete telescope are discussed and shown to be independent of the accommodation of the observer. Seventeen sets of curves are given for as many different lenses, and an illustrative discussion of one set of curves, together with a general description of the types of lenses represented by each group of curves. (Nov. 3, 1917.) 29 pp. Price, 5 cents.

S312. Wave-Length Measurements in Spectra from 5600A to 9600A. . . . . *W. F. Meggers*

The arc spectra of 20 of the chemical elements have been photographed in the red and adjacent infra-red regions. The photographs were made on dicyanin-stained plates with the aid of a concave grating of 640 cm radius. Wave-length measurements in international angstroms are given for the following elements: Lithium, sodium, potassium, rubidium, caesium, copper, calcium, strontium, barium, and magnesium. These results are of importance in spectroscopic analysis and for the discussion of regularities in spectra. (Jan. 16, 1918.) 25 pp. Price, 10 cents.

S313. The Specific Heat of Liquid Ammonia. . . . . *Nathan S. Osborne and Milton S. Van Dusen*

The specific heat of liquid ammonia has been determined throughout the temperature interval $-45°$ to $+45°$ C. by use of a calorimeter specially designed for the peculiar conditions. This calorimeter is of the aneroid or unstirred type and contains important refinements affecting the accuracy of measurements.

Two independent methods of measurement were employed, each of which avoids sources of error possessed by the other, and each of which gives results which are reducible to the same basis, namely, the specific heat of the liquid, kept saturated.

Heat developed and measured electrically is distributed automatically by conduction and convection to the calorimeter and contents whose temperatures are measured by a platinum thermometer. In one method the material is kept at saturation, in the other at constant pressure. (Dec. 13, 1917.) 36 pp. Price, 5 cents.

S314. The Latent Heat of Pressure Variation of Liquid Ammonia. *Nathan S. Osborne and Milton S. Van Dusen*

The latent heat of pressure variation of liquid ammonia has been determined by three independent methods—first, directly by calorimetric measurement; second, by computation from the expansivity directly observed; and, third, by computation from the specific volume of the saturated liquid and the compressibility.

The purpose of the determinations was to furnish data for use in correlating measurements of specific heat of liquid ammonia made at constant pressure with measurements made under saturation conditions. (Nov. 19, 1917.) 6 pp. Price, 5 cents.

S315. The Latent Heat of Vaporization of Ammonia. . . . . *Nathan S. Osborne and Milton S. Van Dusen*

The latent heat of vaporization of liquid ammonia has been determined throughout the temperature interval $-42°$ to $+52°$ C by direct measurements, using a calorimeter specially designed for the particular problem. This instrument is of the aneroid or unstirred type, the ammonia being the only liquid in the calorimeter. Heat developed and measured electrically

in a coil is transmitted by conduction and convection to the ammonia, and is expended in the evaporation of a determined amount which is withdrawn as superheated vapor. Accessory data from other sources are required only in the computation of small correction terms. The results are expressed by an empirical equation and a table of values given for every degree from $-45°$ to $+55°$ C.

By combining the data for the heat of vaporization with the data for specific heat of the saturated liquid from a previous investigation, the specific heat of saturated ammonia vapor is obtained and a table of values of this quantity is given in an appendix. (Dec. 21, 1917.) 34 pp. Price, 10 cents.

S316. Gas Interferometer Calibration.....*J. D. Edwards*

Describes a simple and accurate method of calibrating the Zeiss-Rayleigh gas interferometer. (Dec. 8, 1917.) 7 pp. Price, 5 cents.

S317. Resonance and Ionization Potentials for Electrons in Cadmium Vapor...*John T. Tate and Paul D. Foote*

The object of this investigation has been the determination of the resonance and ionization potentials for electrons in cadmium vapor. Resonance collision of the electron with the atom was observed at 3.88 volts, and inelastic impact resulting in ionization was observed at 8.92 volts. The single line spectrum of cadmium is 3260.17 A. If we substitute the frequency corresponding to this wave length in the relation $h\nu=eV$ where $h=6.56 \cdot 10^{-27}$ erg. sec., e electronic change and V the resonance potential we obtain $V=3.79$ volts in good agreement with the above. On the basis of Bohr's theory the ionization potential should be 8.97 in most excellent agreement with the experimentally determined value. (Feb. 9, 1918.) 8 pp. Price, 5 cents.

S318. The Application of Dicyanin to the Photography of Stellar Spectra..... *Paul W. Merrill*

The Bureau has had considerable success in photographing extreme red and infra-red radiations on plates sensitized with dicyanin. This article describes the application of these plates to stellar spectroscopy. The experiments were carried out at the Harvard College Observatory, employing the 24-inch reflector with objective prism. Fraunhofer's A band (wave length 0.760) and a considerable region of greater wave length were photographed in numerous stellar spectra. Several new stellar bands were discovered. The general conclusions are as follows: (1) Many stellar spectra can be photographed with dicyanin in the region of wave length 0.80; (2) in favorable cases they can be well observed to 0.85; and (3) the region 0.70 contains features of importance, especially in the latter types. (Apr. 13, 1918.) 19 pp. Price, 10 cents.

S319. Instruments and Methods Used in Radiometry III: The Photoelectric Cell and Other Selective Radiometers.....*W. W. Coblentz*

The present paper deals with the application of certain physical and chemical properties of matter as a means of quantitatively measuring radiant energy. Three types of selective radiometers are discussed, viz, the photoelectric cell of potassium and other alkali metals, the selenium cell, and the photographic plate. The photoelectric cell appears to meet the requirements of a quantitative radiometer and may be used for measuring ratios of intensities extending from the blue throughout the ultra-violet part of the spectrum. (June 17, 1918.) 30 pp. Price, 10 cents.

S320. Additions to the Formulas for the Calculation of Mutual and Self Inductance.....*F. W. Grover*

This paper furnishes a list of formulas for the calculation of mutual and self inductance which have appeared since the publication of the earlier paper dealing with same subject (S169).

Some of the formulas here given, notably those for eccentrically placed circles, provide a solution for cases where none has been previously available; others of the formulas are extensions of formulas already well known, or cover cases where earlier useful expressions are available.

No attempt has been made to include all the recent formulas, but in making a selection the author has endeavored to present only those whose

form is well adapted to numerical computation or those for which tables have been prepared which render calculations reasonably simple. (June 24, 1918.) 34 pp. Price, 10 cents.

S321. Thermal Expansion of Alpha and of Beta Brass Between 0° and 600° C, in Relation to the Mechanical Properties of Heterogeneous Brasses of the Muntz Metal Type. *Paul D. Merica and L. W. Schad*

In the course of investigation of the failure of brass articles, rods, bolts, etc., by cracking, instances have been observed in which cracking occurred in brass articles which had been quickly cooled from a forging or annealing temperature by quenching or otherwise, and it was considered possible that this may have been due to the development of local stresses in the brass during such cooling. This study was made with a view to ascertaining the approximate magnitude of the local stresses which might be set up in heterogeneous brasses of the type of Muntz metal owing to the difference in thermal expansivity between the two constituents of it. (May 9, 1918.) 20 pp. Price, 10 cents.

S322. Photoelectrical Sensitivity of Bismuthinite and Various Other Substances. . . . . *W. W. Coblentz*

This paper summarizes the results of an investigation of various substances (1) for an increase in electrical conductivity caused by the action of light upon them, and (2) for electrical discharging activity when they were charged to a negative potential, in an evacuated chamber and exposed to light.

Photoelectrical activity was observed in gallium, silver sulphide, selenium, stibnite, boulangerite, jamesonite, cylindrite, bismuthinite, and molybdenite. No activity was observed in tellurium, boleite pyrites, silicon, and mixtures of sulphides of lead and antimony. Experiments are described on selenium, platinum, gold leaf, etc., when used with an audion amplifier as a photophone. (June 14, 1918.) 14 pp. Price, 5 cents.

S323. Some Characteristics of the Marvin Pyrheliometer. . . . . *Paul D. Foote*

The calibration of a Marvin pyrheliometer by two methods—the electrical method ordinarily used and also a radiometric method—is described. The two methods are substantially in agreement. The calibrated instrument gave results differing by about 2 per cent from those of a Smithsonian standard pyrheliometer, when the two were used simultaneously in solar measurements. The need of further work is recognized and some of the necessary methods indicated. (June 28, 1918.) 30 pp. Price, 10 cents.

S324. Wave Lengths in the Red and Infra-Red Spectra of Iron, Cobalt, and Nickel Arcs. . . . . *W. F. Meggers and C. C. Kiess*

The arc spectra of iron, cobalt, and nickel were photographed in the red and infra-red regions on plates stained with pinacyanol and dicyanin. A large concave grating was used, and exposures up to 10 hours' duration registered many lines with wave lengths greater than 10 000 A, or 1 micron. In the arc spectrum of iron, 298 lines were measured between the wave-length limits 6750 A and 10 689 A; 606 lines were measured between 5503 A and 11 623 A in the arc spectrum of cobalt, and 290 lines between 5504 A and 10 843 A in the arc spectrum of nickel. These results demonstrate that an invisible long wave interval as large as the entire visible spectrum is accessible to photography with dicyanin-stained plates. (June 29, 1918.) 15 pp. Price, 5 cents.

S325. Spectroradiometric Investigation of the Transmission of Various Substances. . . . . *W. W. Coblentz, W. B. Emerson, and M. B. Long*

This paper gives the spectral transmission of various substances, especially colored fluorite, molybdenite, and colored glasses. In some scientific investigations it is desired to expose large areas to radiant energy

stimuli of a fairly high spectral purity. Some of the substances described in this paper provide a simple means of obtaining narrow spectral bands of energy of high intensity and large area without employing a spectroscope.

By properly combining these substances one can obtain a screen having a narrow band of high transmission at 0.38, 0.50, 0.55, 0.7, 0.8, 1, and 2.2μ.

The data on glasses are also useful in connection with the question of protecting the eyes from injurious radiations. (Aug. 8, 1918.) 24 pp. Price, 5 cents.

S326. Electrical Oscillations in Antennas and Inductance Coils. . . . . *John M. Miller*

An application of the theory of circuits with uniformly distributed inductance and capacity to the oscillations in antennas and inductance coils. The paper treats the natural frequencies of oscillation, etc., and shows how these circuits may be replaced by simple circuits with lumped constants in frequency computations. (Oct. 23, 1918.) 20 pp. Price, 5 cents.

S327. Measurements on the Index of Refraction of Air for Wave Lengths from 2218 A to 9000 A. . . . . *W. F. Meggers and C. G. Peters*

A form of the Fabry and Perot interferometer was used for the measurement of the refractive index of air for various wave lengths at intervals of about 40 A from the extreme ultra-violet at 2200 A, through the visible spectrum and into the infra-red to 9000 A. Complete sets of observations were made on dry air at atmospheric pressure and at temperatures of 0°, 15°, and 30° C. These observations were used in the construction of a table giving the corrections which must be applied to wave lengths measured in air whose density is not normal. The table of corrections to covert wave lengths or frequencies measured in air to their values in a vacuum is also given. (Oct. 31, 1918.) 44 pp. Price, 10 cents.

S328. Variance of Measuring Instruments and Its Relation to Accuracy and Sensitivity. . . . . *Frederick J. Schlink*

This paper treats of the types of error in a measuring instrument which are evidenced by the failure of such instrument to give identical indications for repeated identical values of the quantity being measured. The causes of variance inherent in mechanical couplings are discussed and means proposed for diminution of this error. Means of determining and delineating the variance characteristics of an instrument are illustrated, and the important relation which variance bears to the qualities of accuracy and sensitivity is explained. (Sept. 30, 1918.) 24 pp. Price, 5 cents.

S329. Measurements of Wave Lengths in the Spectrum of Neon. . *Keivin Burns, W. F. Meggers, and P. W. Merrill*

Measurements of 55 lines in the neon spectrum have been made by means of the interferometer, in the region 3369 A to 8495 A. The strong lines in the visible and ultra-violet were compared directly with the fundamental standard. Other lines were compared with well-determined neon lines. One hundred eighty-nine faint lines in the region 5343 A to 8783 A were measured by means of a concave grating.

The constant differences discovered by Watson are found to hold with remarkable exactness in the case of lines which are strong enough to be measured with the highest accuracy. In fact, the differences are exactly constant within the limits set by the accuracy of the wave lengths. (Nov. 12, 1918.) 10 pp. Price, 5 cents.

S330. The Decrease in Ultra-Violet and Total Radiation with Usage of Quartz Mercury Vapor Lamps. . . . . *W. W. Coblentz, M. B. Long, and H. Kahler*

In this paper experimental data are given on the decrease in intensity of the ultra-violet and of the total radiation with usage of quartz mercury vapor lamps.

The measurements were made with a thermopile and a yellow (Noviol shade B) glass. Quartz mercury lamps from the Cooper-Hewitt and the R. W. V. Lamp Co., were examined.

It is shown that there is no marked difference in the per cent of ultra-violet emitted by these lamps when new. The total intensity, as well as the ultra-violet, decreases to one-half to one-third in 1000 to 1200 hours.

Comparative data are given on the ultra-violet component in the radiations from the sun and from the quartz mercury vapor lamp; also data on the dye fading carbon arc lamp. (Nov. 12, 1918.) 20 pp. Price, 5 cents.

S331. A Relation Connecting the Derivatives of Physical Quantities.....*M. D. Hersey*

In this paper it is shown how the theory of dimensions may be used in a differential form; a procedure which appears fruitful particularly in investigating the effect of given sources of error on the performance of measuring instruments.

The examples which led to the necessity for developing this method are discussed at the end of the paper and illustrated by experimental data. (Dec. 30, 1918.) 9 pp. Price, 5 cents.

S332. Preliminary Determination of the Thermal Expansion of Molybdenum.....*Lloyd W. Schad and Peter Hidnert*

The thermal expansion of an exceptionally pure specimen of molybdenum was determined from $-142°$ to $+305°$ C. A short description of the oil bath and of the method used in obtaining high and low temperatures is given.

The results are shown in the form of tables, from which were computed by the method of least squares, the two following empirical equations which satisfy the observations:

$L_t = L_0\,(1 + 5.15\,t \times 10^{-6} + 0.00570\,t^2 \times 10^{-6})$ and

$L_t = L_0\,(1 + 5.01\,t \times 10^{-6} + 0.00138\,t^2 \times 10^{-6})$

where L_t is the length of the specimen at any tempearture t within the proper range; in the first case $19°$ to $-142°$ and in the second case $19°$ to $+305°$ C. The probable error of the length computed from these equations is less than 3×10^{-6} per unit length. (Jan. 29, 1919.) 9 pp. Price, 5 cents.

S333. Optical Conditions Accompanying the Striae which Appear as Imperfections in Optical Glass.
.....*Lieut. Commander A. A. Michelson, U. S. N.*

Striae are conveniently divided into two classes: (1) Those which appear as isolated bright streaks; and (2) those in which such streaks are numerous, forming bright irregularly continuous bands. Optical investigation with two forms of interferometers show that the former are due to laminæ of smaller index and of thickness of the order of one-hundredth of a mm. They do not seriously affect the optical qualities of lenses or prisms. The second class of striae, in general, does not affect the optical performance; but, in the case of lenses and plane parallel plates, etc., in which the light traverses the striae at approximately normal incidence, the performance may be quite as good as with a perfect specimen. (Mar. 20, 1919.) 5 pp. Price, 5 cents.

S334. New Forms of Instruments for Showing the Presence and Amount of Combustible Gas in the Air.
.....*E. R. Weaver and E. E. Weibel*

A study has been made of the combustion of small amounts of gas in the air at the surface of electrically heated wires and the application of this phenomenon to the design of instruments for the purpose of detecting the presence and indicating the amount of combustible gas in the air. As a result of this study three types of instruments, each especially adapted to certain uses, have been designed, tested, and found to work satisfactorily.

The action of one of these instruments depends upon a resistance change, one upon a heating effect upon an adjacent bimetallic strip, one upon a light emitted from the heated wire. A discussion of the principles involved in the design of the instruments and specifications for their construction are given. (June 23, 1919.) 44 pp. Price, 15 cents.

S335. The Effect of Rate of Temperature Change on the Transformations in an Alloy Steel.....*H. Scott*

Cooling curves on an alloy steel of the composition C 1.75, Mn 1.26, Cr 15.0, and Co 2.90 show two transformations on cooling from 920° C, one being observed at about 750° C, with cooling rates slower than 0.70° C per second, and the other at about 400° C, with cooling rates faster than 0.15° C per second. Troostite is formed at the higher temperature and martensite at the lower. Heating curves of the martensite steel show an evolution of heat ending at about 645° C, which represents the precipitation of the carbide held in solution. This phenomenon is accompanied by an increase of 10 to 15° C in the temperature of Ac1–3. (July 10, 1919.) 10 pp. Price, 5 cents.

S336. A Simplification of the Inverse-Rate Method for Thermal Analysis.....*P. D. Merica*

The use of stop watches in taking inverse-rate curves in thermal analysis is described, and it is shown that they may be substituted for the chronograph, which is often used without sacrificing accuracy or sensitivity. One operator is able to record the successive time intervals for the inverse-rate curve with their aid, and no time is subsequently required for the reading and counting of the chronograph record; the intervals so recorded may be plotted directly. (July 11, 1919.) 4 pp. Price, 5 cents.

S337. Constitution and Metallography of Aluminum and its Light Alloys with Copper and with Magnesium .....
P. D. Merica, R. G. Waltenberg, and J. R. Freeman, jr.

The solubility temperature curves of $CuAl_2$ and of Mg_4Al_3 in aluminum were determined by the method of annealing and microscopic observation. Aluminum dissolves about 4.2 per cent of copper as $CuAl_2$ at 525° C and about 12.5 per cent of magnesium as Mg_4Al_3 at 450° C. The solubility of both compounds decreases with decreasing temperature. Observations are made regarding the structural condition of iron and of silicon in commercial aluminum. (Aug. 16, 1919.) 14 pp. Price, 10 cents.

S338. Some Optical and Photoelectric Properties of Molybdenite.....*W. W. Coblentz and H. Kahler*

The transmissivity, reflectivity, and photoelectrical sensitivity of molybdenite, MoS_2, was determined in the spectral region of the 0.36μ to 9μ. The effect of temperature, humidity, and intensity of the exciting radiations, etc., upon the electrical conductivity was investigated. Molybdenite is conspicuous for its high photoelectrical sensitivity to infra-red rays, extending to 3μ, being especially sensitive for radiations at wave lengths $\lambda=0.73\mu$, 0.85μ, 1.02μ, and 1.8μ. Samples of molybdenite from various localities differ greatly in sensitivity, which from the tests at liquid-air temperature seems to be one of degree rather than one of quality. (Aug. 16, 1919.) 30 pp. Price, 10 cents.

S339. Standardization of the Sulphur Boiling Point.....
.....*E. F. Mueller and H. A. Burgess*

Experiments were made to determine the effects of various experimental conditions, such as type of radiation shield, type of apparatus, purity of sulphur, etc., upon temperature observed with a resistance thermometer in the sulphur-boiling apparatus. The variation of boiling point with pressure over the range 700 to 800 mm was redetermined. Proposed standard specifications for the boiling-point apparatus and its use are given in an appendix. (Oct. 4, 1919.) 22 pp. Price, 5 cents.

S340. A Standardized Method for the Determination of Solidification Points, Especially of Naphthalene and Paraffin. . *R. M. Wilhelm and J. L. Finkelstein*

This paper deals with a method of determining the solidification point of naphthalene recommended at a conference of Bureau of Standards and United States customs officials. The method is shown to be applicable, with obvious modifications, to the determination of the solidification point of paraffin and other substances. (Sept. 12, 1919.) 13 pp. Price, 5 cents.

S341. Airplane Antenna Constants. . . . . *J. M. Cork*

Methods for measuring the capacity, inductance, resistance, and natural wave length; also the directional transmitting effect of airplane antennas, with the plane in flight, are described. Using these methods, results obtained upon various forms of fixed antennas, as well as one, two, and four trailing wires, are recorded. (Sept. 17, 1919.) 15 pp. Price, 5 cents.

S342. Reflecting Power of Stellite and Lacquered Silver. . . . . *W. W. Coblentz and H. Kahler*

The reflecting power of stellite varies somewhat in the visible spectrum, depending upon the homogeneity and no doubt upon the exact composition of the alloy. Measurement on lacquered silver mirrors, made before and after exposure to ultra-violet light, show that, owing to photochemical action in the lacquer, the silver is turned brown in color, thus reducing the reflecting power. (Sept. 11, 1919.) 3 pp. Price, 5 cents.

S343. Location of Flaws in Rifle-Barrel Steel by Magnetic Analysis. . . . . *R. L. Sanford and Wm. B. Kouwenhoven*

This paper describes an investigation which was undertaken for the purpose of determining whether an application of magnetic analysis was practicable for the detection of flaws in rifle-barrel steel. By means of apparatus especially constructed for the purpose, a large number of bars were explored for magnetic uniformity along their length. The results demonstrated that the method is amply sensitive to detect and locate flaws. Further study is necessary to determine to what degree the sensitivity should be reduced in order not to cause the rejection of material which is satisfactory for all practical purposes, and also to determine the type and magnitude of the effect which will be produced by a pipe. The investigation is being continued by the Winchester Repeating Arms Company. (Oct. 3, 1919.) 12 pp. Price, 5 cents.

S344. Spectral Photoelectric Sensitivity of Silver Sulphide and Several Other Substances. . . . . *W. W. Coblentz and H. Kahler*

Data are given on the change in the electrical resistance of the sulphide of silver and of bismuth when exposed to radiations of wave lengths extending from 0.6μ to 3μ. Measurements were also made on galena, cylindrite, pyrites, and jamesonite. The effect of temperature, of the intensity of the exciting light, and of mechanical working upon photo-electrical sensitivity of silver sulphide was investigated. (Sept. 19, 1919.) 19 pp. Price, 5 cents.

S345. Measurements of Wave Lengths in the Spectra of Krypton and Xenon. . . . . *Paul W. Merrill*

This paper records photographic measurements of wave lengths in the spectra of krypton and xenon, principally in the red and infra-red. In krypton 37 new lines were measured between 6576 A and 8928 A, in xenon 52 new lines between 6318 A and 9162 A. In this region there are numerous strong lines which are probably among the most important in the spectra of these elements. Notable among these are xenon lines at 8231 and 8280. These and other lines may be of value as wave-length standards in the infra-red. (Oct. 3, 1919.) 8 pp. Price, 5 cents.

S346. Oxygen Content by the Ledebur Method of Acid Bessemer Steels Deoxidized in Various Ways. ..... *J. R. Cain and Earl Pettijohn*

It is shown that the Ledebur method for determining oxygen in steels indicates no marked difference in oxygen content of steels practically identical as to chemical composition and heat treatment, but made by different deoxidation treatments. Some differences in physical properties of such steels are also shown. (Nov. 11, 1919.) 12 pp. Price, 5 cents.

S347. The Heat Treatment of Duralumin..... ..... *P. D. Merica, R. G. Waltenburg, and H. Scott*

A study was made of the heat treatment of alloys of the type of duralumin and the effect on the mechanical properties observed of variations in the various heat-treatment conditions. Conclusions are drawn relative to the best conditions for commercial heat treatment of this alloy. A theory of the mechanism of hardening during aging of duralumin is proposed, which is based upon the decreasing solubility with decrease of temperature of $CuAl_2$ in aluminum. The precipitation of this compound, suppressed during quenching, proceeds during aging, and takes place in highly dispersed form. To the presence of this highly dispersed constituent is due the hardness of the aged alloy. (Nov. 15, 1919.) 46 pp. Price, 10 cents.

S348. Use of a Modified Rosenhain Furnace for Thermal Analysis..... *H. Scott and J. R. Freeman*

The furnace developed by Rosenhain for the thermal study of metals has several objectional features which the authors have corrected in building a furnace of that type. A description of this improved furnace is given with the advantages derived from the modifications, and its operation as applied to inverse-rate thermal analysis is discussed. The construction of the furnace is shown in sufficient detail to permit reproduction. (Oct. 24, 1919.) 7 pp. Price, 5 cents.

S349. Photoelectric Spectrophotometry by the Null Method..... *K. S. Gibson*

Reliable determinations of spectral transmission throughout the green, blue, and violet have been made by means of the photo-electric null method described in the paper. All errors have been eliminated, as well as the necessity of any tests, calibrations, or corrections, in connection with the current-irradiation law or the dark currents of the photo-electric cells, or with electrometer deflection methods. Measurements can be made from 380 to 650 millimicrons, the best range being from 410 to 550. Measurements of spectral diffuse reflection relative to that of magnesium carbonate have also been made. (Oct. 11, 1919.) 28 pp. Price, 5 cents.

S350. Equilibrium Conditions in the System Carbon, Iron Oxide, and Hydrogen in Relation to the Ledebur Method for Determining Oxygen in Steel..... *J. R. Cain*

It is shown that mixtures of iron oxide and Acheson graphite are not reduced, and mixtures of iron oxide with "cemented" iron or white iron (annealed or unannealed) are reduced at 900° C by the carbon in them, when hydrogen is passed over them at rates of 2 liters per hour or faster. Because of these facts it is probably impossible to determine by the Ledebur method more than 75 per cent of the oxygen present in steels as ferrous oxide. The effect of rate of passage of hydrogen on the Ledebur oxygen content of certain steels is shown. (Nov. 10, 1919.) 14 pp. Price, 5 cents.

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S351. Dependence of the Input Impedance of a Three-Electrode Vacuum Tube upon the Load in the Plate Circuit ..... *John M. Miller*

Because of the capacities between the electrodes of a three-electrode vacuum tube, the input impedance, which determines the input voltage supplied to the grid of the tube by the apparatus in the input circuit, depends upon the electrical characteristics of the plate or output circuit. In this paper theoretical relations are established which permit the input impedance to be calculated when the impedance in the plate circuit is known. These relations are also checked by experiment. (Nov. 21, 1919.) 19 pp. Price, 5 cents.

S352. Thermal Expansion of Insulating Materials..... ..... *Wilmer H. Souder and Peter Hidnert*

The present paper gives data on the thermal expansion of some of the more important insulating materials. In most cases the expansions are too irregular to justify the use of the general quadratic equations. A knowledge of the thermal behavior of these materials is essential before assembling them in certain types of apparatus subjected to wide temperature variations. The most striking peculiarities are: (1) The wide range in the values of the coefficients of porcelain from 1.6 to 19.6 millionths per unit length per degree centigrade. (2) The three varieties of expansions for porcelain; namely, straight line, concave, and convex expansion curves. (3) The shrinkage and the loss in weight of the phenol and similar compounds when subjected to excessive heat treatment. (4) The permanent growth and variations of different marbles when subjected to heat treatment. (5) The negative coefficient of expansion of marble at low temperatures. (Dec. 27, 1919.) 30 pp. Price, 10 cents.

S353. Variation in Direction of Propagation of Long Electromagnetic Waves..... *A. Hoyt Taylor*

The observed direction of radio waves as obtained with a direction finder varies with time, when long waves are used such as those from very high power stations. The variations of direction are of the order of 90° for very long waves. No such large variations are found for short damped waves produced by spark apparatus. A method of increasing the sharpness of determination of direction has been worked out. A theoretical explanation of the variations of direction is given, based on the existence of media in the earth's atmosphere capable of reflecting and refracting the waves. (Nov. 29, 1919.) 15 pp. Price, 5 cents.

S354. Principles of Radio Transmission and Reception with Antenna and Coil Aerials..... *J. H. Dellinger*

The functioning of the two principal types of radio aerials is worked out quantitatively from fundamental electromagnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type of transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given. Desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays, and submarine aerial are not among the subjects treated. (Dec. 11, 1919.) 60 pp. Price, 10 cents.

S355. The Determination of the Output Characteristics of Electron Tube Generators.....*Lewis M. Hull*

Owing to saturation and rectification effects in three-electrode vacuum tubes, the currents which they deliver to any type of output circuit, when used as a generator, are heavily loaded with harmonics. Experimental results indicate that the frequency of the oscillating currents generated is the natural frequency of the output circuit. Hence this circuit behaves as a filter in series with the tube and the direct-current power system, and the useful output current is approximately sinusoidal, whatever the distortion of the tube currents, and depends in amplitude solely upon the fundamental constituents of the tube currents. General expressions are derived for the power and current output in terms of static characteristics of the generating tube and are corroborated by experimental results obtained with a particular tube. (Dec. 1, 1919.) 21 pp. Price, 5 cents.

S356. Notes on the Microstructure of Iron and Mild Steel at High Temperatures.....
.....*Henry S. Rawdon and Howard Scott*

The structure of iron and mild steel at high temperatures was examined by means of heat etching, i. e., heating polished specimens in vacuo; a distinct and characteristic pattern corresponding to the structure of the different allotropic forms is produced upon the polished face. A considerable change in composition occurs in the surface metal upon heating, due to loss of carbon. This is most pronounced just above the A_1 transformation. The increased rate of diffusion of carbon in iron at higher temperatures aids in making the change at the surface at such temperatures. The pattern produced by heat etching reveals not only the condition of the surface metal but also that of the interior. (Mar. 15, 1920.) 9 pp. Price, 10 cents.

S357. Constants of Radiation of a Uniformly Heated Inclosure.....*W. W. Coblentz*

A recalculation is given of data previously published (Scientific Papers 261 and 262). The new value of the coefficient of total radiation is $\sigma = 5.722 \times 10^{-12}$ watt cm^{-2} deg.$^{-4}$, which is in agreement with the value previously published. Experimental data are given on the absorption of dry and humid air. The effect of atmospheric absorption is discussed, and it is concluded that, if corrections are made for absorption by water vapor, the value of σ obtained recently at Naples is close to the average value, $-\sigma = 5.7$. (Jan. 16, 1920.) 7 pp. Price, 5 cents.

S358. Concerning the Annealing and Characteristics of Glass.....*A. Q. Tool and J. Valasek*

Methods available for determining the temperature at which glass should be annealed were tested, and the annealing temperatures are given for a number of glasses. Determinations of the critical ranges for these glasses were also made, and the results are discussed. The relations which possible transformations occurring in this range bear to the annealing procedure are especially considered. Methods for determining the length of time the glass should be held at the annealing temperature and the mode of cooling were investigated and some conclusions are given. (Jan. 31, 1920.) 35 pp. Price, 10 cents.

S359. Efflux of Gases through Small Orifices.....
.....*Edgar Buckingham and Junius David Edwards*

The paper describes experiments undertaken with the object of throwing light on the difficulties encountered in the practical use of Bunsen's method of determining specific gravity. An elementary theory of the effects of viscosity and thermal conductivity is developed and applied to the observations, and it is shown that, within the limits of accuracy of the experiments, this theory accounts for most of the observed facts. (Jan. 28, 1920.) 42 pp. Price, 10 cents.

S360. Methods for Computing and Intercomparing Radiation Data.....*W. W. Coblentz*

This paper gives a simple method for computing spectral energy curves, using the Planck formula. A table of values of log $(e^u - 1]$ is given. The paper gives also a chart for intercomparing thermal radiation constants with similar data obtained indirectly from photoelectric X-ray and ionization potential measurements. (Jan. 31, 1920.) 8 pp. Price, 5 cents.

S361. Magnetic Testing of Straight Rods in Intense Fields.....*W. L. Cheney*

Previous experiments on high inductions are discussed. A method which is suitable for measuring the magnetic properties of fairly long rods of ferromagnetic materials, when magnetized in intense fields, is described. Normal induction data are compared with those obtained by the Burrows method and found to agree satisfactorily within the range of the latter. From the normal induction data the intensity of magnetization and reluctivity are calculated and discussed. (Feb. 21, 1920.) 14 pp. Price, 5 cents.

S362. Distribution of Energy in the Spectrum of an Acetylene Flame.....*W. W. Coblentz*

New data are given on the distribution of energy in the spectrum of a flat and of a cylindrical acetylene flame. A revision is made of the spectral energy data previously published. The optical properties of the flame are discussed, and it is shown that, owing to the high selective absorption in the visible spectrum, the apparent color temperature is higher than that obtained from consideration of the maximum emission in the infra-red. The radiometric as well as the color temperature measurements indicate that in the visible spectrum from 0.48 to 0.75 μ the spectral energy distribution of the cylindrical flame is that of a black body at 2360° K. The visibility data (Scientific Paper No. 303) remain unchanged. A table is given of the visibility of the average of 29 observers having closely normal color vision. (Feb. 12, 1920.) 13 pp. Price, 5 cents.

S363. Preparation and Reflective Properties of Some Alloys of Aluminum with Magnesium and with Zinc.....*R. G. Waltenberg and W. W. Coblentz*

This paper gives the manner of preparation and determination of the spectral reflective properties of alloys of aluminum with magnesium and with zinc. All of these alloys tarnish in time and hence are not suitable for mirrors where permanency is of prime importance. The compound of aluminum and magnesium, Al_3Mg_4, deteriorates less rapidly than any of the other alloys examined and could be used in apparatus where a highly reflecting mirror is desired for a short time. A reflectivity of 92 per cent at 0.7 μ was obtained with this compound. The zinc-aluminum alloy has a minimum reflectivity at 0.9 μ. An examination of the reflectivity of pure zinc disclosed a similar reflectivity minimum at 1.0 μ. (Feb. 12, 1920.) 6 pp. Price, 5 cents.

S364. Relation of Voltage of Dry Cells to Hydrogen-Ion Concentration.....*H. D. Holler and L. M. Ritchie*

The potentials of electrodes consisting of Acheson graphite and certain manganese ores was found to be a logarithmic function of the hydrogen-ion concentration of the solution in contact with the electrode, while that of electrodes containing a chemically prepared oxide of manganese is independent of hydrogen-ion concentration. The relation between the potential of the manganese dioxide electrode and hydrogen-ion concentration explains variations in open-circuit voltages of dry cells and accounts for a portion of the polarization of a dry cell on discharge. (Feb. 24, 1920.) 10 pp. Price, 5 cents.

S365. A New Interferential Dilatometer.....*Irwin G. Priest*

Description of a dilatometer for measuring small differential thermal or other changes in length by means of the change in width of interference fringes. The principal practical feature of the method is that the sample is one small pin easily prepared. The method gives results as accurate as the previously used standard Fizeau-Pulfrich method, while it is, in many cases, more convenient and direct and possesses several other advantages. The instrument has actually been used at the Bureau of Standards for some time in determining thermal expansion. It is thought that it would also be applicable to the measurement of small length changes due to loss of moisture, magnetization, mechanical stress, etc. (Feb. 28, 1920.) 12 pp. Price, 5 cents.

S366. Contrast Sensibility of the Eye.....
.....*Enoch Karrer and E. P. T. Tyndall*

To obtain data on the contrast sensibility of the eye under conditions similar to those encountered in searchlight illumination, laboratory experiments were performed simulating as closely as possible actual conditions. An illuminated strip was projected on a field of known brightness. The length of the strip was increased from zero to a length just visible to the observer. The results obtained are expressed by curves showing the relation between (1) strip length (visual angle) and field brightness, for constant contrast between strip and field; (2) strip length and contrast between field and strip, for constant values of field brightness. These curves lie in groups consistent with each other, and those obtained for the two observers are similar. (Mar. 8, 1920.) 16 pp. Price, 5 cents.

S367. The Turbidity Standard of Water Analysis....*P. V. Wells*

The paper describes an investigation of the methods of measuring turbidity. The standards of turbidity used in water analysis were intercompared with a turbidimeter constructed at the Bureau, showing variations from the average of more than 50 per cent in some cases, and averaging 18 per cent. Possible means of improving the standard are suggested. (Mar. 17, 1920.) 29 pp. Price 10 cents.

S368. Ionization and Resonance Potentials for Electrons in Vapors of Lead and Calcium.....
.....*F. L. Mohler, Paul D. Foote, and H. F. Stimson*

The resonance and ionization potentials of lead are 1.26 and 7.93 volts, respectively. The line $\lambda=10\,291$ gives the probable theoretical value for the former as 1.198 volts. Calcium has two resonance potentials, 1.90 volts and 2.85 volts, of which the first is most prominent. Ionization was observed at 6.01 volts. The following spectral frequencies determine these potentials:

First resonance.....	$1.5S-2p_2$,	$\lambda=6572.78$ A, $V=1.877$ volts
Second resonance.....	$1.5S-2p$,	$\lambda=4226.73$ A, $V=2.918$ volts
Ionization.....	$1.5S$,	$\lambda=2027.56$ A, $V=6.08$ volts

(Feb. 26, 1920.) 16 pp. Price, 5 cents.

S369. Vapor Pressure of Ammonia.....
.....*C. S. Cragoe, C. H. Meyers, and C. S. Taylor*

Previous measurements are briefly reviewed, tabulated, and compared with authors' results. Methods of purification of the ammonia are briefly described. A detailed description is given of the apparatus and procedure employed in the measurements by the static method from $-78°$ to $+70°$ C. The phenomenon of hysteresis was observed near the normal boiling point with a commercial sample containing air. Lags in coming to equilibrium were encountered and studied. The normal boiling point was determined by the static and dynamic methods as $-33.35°$ C. Two empirical equations represent closely the results and also the latest critical data. One hundred twenty-two measurements from $-78°$ to $+25°$ C made with direct observation of mercury columns agree with the equations within 1 mm of mercury. Twenty-eight measurements from $+15°$ to $+70°$ C made with an accurately calibrated piston gage agree within 3 mm of mercury. (Apr. 10, 1920.) 42 pp. Price, 10 cents.

S370. A New Form of Vibration Galvanometer.....*P. G. Agnew*

Vibration galvanometers are very useful in null measurements, but have not been much used in industrial laboratories on account of their being sensitive to external vibrations and requiring delicate adjustments. The present instrument, which has a sensitivity higher than other forms of the moving-iron type, but less than that of the most sensitive forms of the moving-coil type, has the advantages of sturdiness, quick responsiveness, and freedom from the effects of external vibration. It consists essentially of a fine steel wire mounted on one pole of a permanent magnet, and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes. (Mar. 12, 1920.) 10 pp. Price, 5 cents.

S371. A New Cadmium Vapor Arc Lamp.....*Frederick Bates*

A new method for producing a cadmium vapor arc of great brilliancy has been discovered. It was found that the metal gallium readily alloys with cadmium, and that less than 1 per cent is sufficient to radically change the character of the cadmium and greatly reduce its tensile strength, thus eliminating breakage of the lamps. Since gallium has a boiling point above 1500° C, the vapor pressure relation which exists between cadmium and mercury is reversed when compared with cadmium and gallium. The cadmium therefore acts as the energy carrier when used in combination with gallium in a quartz lamp. (Apr. 10, 1920.) 8 pp. Price, 5 cents.

S372. Wave Lengths Longer than 5500 A in the Arc Spectra of Seven Elements.....
.....*C. C. Kiess and W. F. Meggers*

The yellow, red, and infra-red regions of the arc spectra of titanium, vanadium, chromium, manganese, molybdenum, tungsten, and uranium were photographed with a large concave grating spectrograph. The photographs were made on plates sensitized to these spectral regions by means of pinacyanol and dicyanin dyes. The wave lengths of more than 2500 spectral lines were measured extending from the green at 5500 A into the infra-red beyond 9700 A. So far as known, impurity lines and spurious lines have been eliminated from the wave-length tables. Frequency differences which are suspected of being constant have been found in each of the spectra. (May 7, 1920.) 26 pp. Price, 5 cents.

S373. Characteristics of Striae in Optical Glass.....
.....*T. T. Smith, A. H. Bennett, and G. E. Merritt*

Striae are imperfections in optical glass which are revealed by and cause consequent damage because of their refractive index being slightly different from the surrounding glass. Various methods for detecting their presence are described, and photographic illustrations by a highly sensitive one are given. The comparative effects of striae on the definition given by binocular prisms, in which striae are present in different degrees, are exhibited by photographs of an artificial star taken through these prisms. The refractive indices were found to be either above or below those of the surrounding glass by about 2 in the fourth decimal place. It is concluded that in most visual work a few striae do real damage only when in focus or nearly in focus in the field of view. (May 3, 1920.) 18 pp. Price, 5 cents.

S374. An Integration Method of Deriving the Alternating-Current Resistance and Inductance of Conductors.....*H. L. Curtis*

An integration method of deriving formulas for the alternating-current resistance and inductance of a straight cylindrical conductor by the use of both real and imaginary power series, and for a return circuit by the use of imaginary power series, together with an application to experimental results. (Apr. 7, 1920.) 32 pp. Price, 10 cents.

S375. The Double-Polarization Method for Estimation of Sucrose and the Evaluation of the Clerget Divisor . . . . . *R. F. Jackson and Clara L. Gillis*

The velocity of inversion of sucrose as a function of temperature and concentration of hydrochloric acid has been determined and the time required for 99.99 per cent inversion has been computed. The rate of decomposition of invert sugar in the presence of acid has been measured. By using these data the value of the Clerget divisor for complete inversion and in absence of decomposition of invert sugar has been determined. The prevailing accepted value has been found to be in considerable error. Several isolated empirical values at different concentrations of acid have been correlated by a single formula. Methods of analysis of sucrose when mixed with various classes of impurities have been suggested, and tables have been prepared for convenient operation. (Mar. 30, 1920.) 70 pp. Price, 10 cents.

S376. Critical Ranges of Some Commercial Nickel Steels . . . . . *Howard Scott*

The thermal critical ranges of some of the industrially important nickel steels have been investigated by the method usually employed at the Bureau. It was found that the Ac_3 transformation is more sharply displayed at slower rates of temperature change, within limits, and that the end of the Ac_3 range, as interpreted, is the fundamental criterion of heat-treatment temperatures. Curves are given to show the effect of carbon on the Ac ranges of carbon steels and the effect of nickel on the Ac and Ar ranges of 0.40 per cent carbon steels. The effect of nickel and carbon on the end of Ac_3 is also estimated. (Apr. 6, 1920.) 20 pp. Price, 5 cents.

S377. The Intercrystalline Brittleness of Lead . . . . . *H. S. Rawdon*

Lead sometimes assumes a brittle granular form due to corrosion. An explanation offered by previous investigators for the change is that it is due to an allotropic transformation, the product being analogous to the well-known gray-tin. Contract with a weak acid solution of a lead salt has been claimed to be the agency for promoting the change. The rate at which the brittleness is produced is proportional to the purity of the lead. Practically all impurities in lead are lodges between the grains. The preferential attack of these impurities accounts for the brittleness. Even specimens of exceptional purity (99.993 per cent) immersed in neutral lead-acetate solution developed intercrystalline brittleness. No evidence of the existence of allotropic lead analogous to gray-tin could be obtained. (Apr. 6, 1920.) 18 pp. Price, 5 cents.

S378. A New Spectropyrheliometer and Measurements of the Component Radiations from the Sun and from a Quartz Mercury Vapor Lamp . . . . . *W. W. Coblentz and H. Kahler*

The spectropyrheliometer consists of a quartz spectograph and cylindrical condensing lens, placed upon an equatorial mounting. In this manner the ultra-violet absorption in heliostat mirrors is avoided. Data are given on the relative components of infra-red visible and ultra-violet radiation from the sun, and from a quartz mercury arc lamp; also data on the gas-filled tungsten lamp, the iron arc, and the carbon arc. In two appendices methods are given for excluding ultra-violet light from buildings, and for protecting projection lantern films from the heat of the lamp. (Apr. 9, 1920.) 20 pp. Price, 5 cents.

S379. Reflecting Power of Monel Metal, Stellite, and Zinc
. . . . . *W. W. Coblentz*

Data are given on the reflecting power of monel metal, stellite, and zinc in the visible and in the infra-red spectrum. The reflectivity of monel metal is practically the same as that of nickel, except in the short wave lengths where the reflecting power is somewhat lower than that of pure nickel. A new determination of the reflectivity of stellite gave values about 1 per cent lower than previously observed in the visible spectrum. (See Scientific Paper No. 342.) The reflectivity of zinc is unique in having a deep minimum at 1μ followed by an unusually high value beyond 2μ. (June 10, 1920.) 4 pp. Price, 5 cents.

S380. The Spectrophotoelectric Sensitivity of Thalofide
. . . . . *W. W. Coblentz*

Experimental data are given on the spectrophotoelectric sensitivity of Case's preparation of thallium-oxy-sulfid, called thalofide, when exposed to thermal radiation of wave lengths extending from 0.58μ to 3μ. This substance has a wide unsymmetrical, complex band of photoelectric sensitivity which terminates abruptly at 1.2μ. The effect of temperature was investigated. It was found that, in common with nearly all photoelectric substances thus far examined, the sensitivity increases the most rapidly on the short wave-length side of the maximum. The application of this substance to stellar radiometry is discussed. (June 17, 1920.) 6 pp. Price, 5 cents.

S381. An Electron Tube Transmitter of Completely Modulated Waves. . . . . *Lewis M. Hull*

In order to utilize a radiofrequency wave train of given power most effectively in a nonoscillating receiving system, it must be completely modulated at some suitable audio frequency. A convenient way of accomplishing this modulation, when an electron tube generator is used, is by supplying the plate circuit of the tube or tubes with an audio-frequency alternating emf. An alternator may be used with suitable transformers to supply both the filament and plate circuits. A self-contained transmitting set of this type has been designed and built at the Bureau of Standards. A description of the set, with photograph and diagrams, is given. Over-all efficiency as high as 35 per cent is obtained with set. Transmission and reception tests are described in which the waves were received by heterodyne methods and also with a crystal detector. (June 18, 1920.) 13 pp. Price, 5 cents.

S382. Notes on the Testing of Magnetic Compasses. . *R. L. Sanford*

The work of the Bureau of Standards on magnetic compasses was undertaken in response to requests for information and cooperation from the War Department and the United States Shipping Board. In the course of the investigation, certain facts concerning the general characteristics of compasses were brought out which were considered to be of interest to users of magnetic compasses. This paper gives a brief discussion of the principal performance characteristics of magnetic compasses together with a description of some of the apparatus which is used at the Bureau for testing. (June 18, 1920.) 7 pp. Price, 5 cents.

S383. Measurement of Hysteresis Values from High Magnetizing Forces. . . . . *W. L. Cheney*

After reviewing former attempts to measure hysteresis values with apparatus of a modified isthmus type and discussing possible causes for errors in observation, an improved method for measuring hysteresis values by means of this apparatus is described. The results agree favorably, within the experimental error, with those obtained on standard types of apparatus. Observations carried as high as $H=2500$ gausses are shown graphically. (June 19, 1920.) 9 pp. Price, 5 cents.

S384. Variation of Residual Induction and Coercive Force with Magnetizing Force..... .....*R. L. Sanford and W. L. Cheney*

This paper is a report of an investigation to ascertain whether or not analytical expressions similar to the reluctivity relationship of Kennelly correctly represent the variation of residual induction and coercive force with the maximum magnetizing force. Hysteresis measurements were made on a number of samples covering a wide range of materials using magnetizing forces up to 2500 gausses. The relationships

$$H_m/B_r = a_1 + b_1 H_m$$
$$\text{and } H_m/H_c = a_2 + b_2 H$$

were found to hold within the limits of the probable experimental error. (June 23, 1920.) 8 pp. Price, 5 cents.

S385. A New Microphotometer for Photographic Densities .....*W. F. Meggers and Paul D. Foote*

The micropyrometer described by Burgess (B. S. Bulletin, **9**, p. 475; 1913) was modified and calibrated so that ammeter readings of the current through the pyrometer lamp, when matched to equal brightness with a portion of an illuminated photographic plate, were readily converted to values of photographic density. Illustrations are given of the use of this instrument for measurements of densities in spectral lines and for speed and color sensitivity measurements of photographic plates. (June 30, 1920.) 10 pp. Price, 5 cents.

S386. Atomic Theory and Low-Voltage Arcs in Caesium Vapor.....*Paul D. Foote and W. F. Meggers*

An extension of Bohr's theory of atomic structure is developed and applied to such phenomena as the operation of arcs below the ionization potential, fluoresence of alkali vapors, single-line, single-series, and group-line spectra. The caesium arc was photographed at various voltages and from λ 3878 to λ 9208. The plate characteristics were determined, and all lines of the spectrum were reduced to a true intensity scale. The existence of a single-line spectrum was shown for voltages less than the ionization potential. As the accelerating voltage is increased above the ionization potential the energy of radiation of frequency 1.5 s—$2p_{1,2}$ is sacrificed for that of the complete line spectrum—a fact which affords a strong argument for Bohr's theory. The ratio of intensity of the components of the first doublet of the principal series is 1.5 independent of the exciting voltage. Further conclusions are drawn for sodium and potassium. Only two types of inelastic atomic-electronic collision occur in vapors of the alkali metals. (July 7, 1920.) 17 pp. Price, 5 cents.

S387. Permeability of Rubber to Gases..... .....*J. D. Edwards and S. F. Pickering*

This paper gives the major details of an extended investigation of the factors governing the permeability of rubber to gases. The permeability of rubber to a number of the more common gases and vapors has been determined. (July 12, 1920.) 36 pp. Price, 10 cents.

S388. Adjustment of Parabolic and Linear Curves to Observations Taken at Equal Intervals of the Independent Variable.....*H. M. Roeser*

Least squares reductions of observations that follow a parabolic or linear law taken at equal intervals of the independent variable frequently occur in physics and engineering practice. Makeshift devices are often employed to evade the arithmetical work of determining the constants of curves which properly represent such data. In this paper the ordinary least squares formulas are subjected to mathematical treatment, and rigorous solutions are evolved which require an ultimate minimum of arithmetical work. A table is furnished from which a large portion of the solutions can be written down from inspection of the observations. Application of the solutions is made to typical problems, and an absolute check with the regular least squares solutions is shown. (July 21, 1920.) 13 pp. Price, 5 cents.

S389. Relative Spectral Transmission of the Atmosphere .....*E. Karrer and E. P. T. Tyndall*

As part of the searchlight investigation of the Bureau some data have been taken on the relative spectral transmission of the atmosphere. Light from an incandescent lamp was reflected by a mirror 600 m distant, and the intensity of this reflected light was compared by means of a spectrophotometer with the intensity of a beam directly from the lamp. Curves are given for three types of weather conditions: (1) Clear and cold; (2) overcast and high humidity; and (3) rainy. The first type shows very little selectivity. The second and third types are similar for wave lengths less than 540μ, there being a decrease in transmission for shorter wave lengths. In the rest of the visible spectrum the curves of the second type present two maxima and a minimum, which are entirely lacking in the curves for rainy weather. The conclusion drawn from these curves is that the transmission of the atmosphere under the conditions prevailing during the experiments is greatest in the yellow and orange regions of the spectrum. (July 21, 1920.) 32 pp. Price, 10 cents.

S390. The Two Common Failures of the Clark Standard Cell.....*E. C. McKelvy and M. P. Shoemaker*

The causes and effects of the cracking of Clark cells at the amalgam terminal and the formation of gas in the amalgam limb are discussed, as are also the methods employed by the authors and others in an attempt to eliminate these defects. It is shown that the cracking of the cell can best be prevented by the very simple expedient of using a cell blank in which platinum wire previously subjected to the action of zinc amalgam is employed as the negative terminal, also that the effects of gas formation can be minimized through the employment of the smallest excess of crystals required to insure saturation at the highest temperature at which the cell is to be used. (July 21, 1920.) 20 pp. Price, 5 cents.

S391. The Measurement of Diffuse Reflection Factors, and a New Absolute Reflectometer.....*A. H. Taylor*

The paper discusses the nature of reflection and describes the various methods which have been used to measure reflection factors. The complete theory and description of a new absolute reflectometer are presented. Thorough tests of the instrument show that it gives correct results. Five absolute methods of determining reflection factors are described, and experimental results with this instrument and two other methods show excellent agreement. The reflection factor of a block of magnesium carbonate was found to be 99 per cent, whereas the previously accepted value was 88 per cent. The reflectometer is portable, and can be used to measure reflection factors of surfaces in situ. (July 28, 1920.) 16 pp. Price, 5 cents.

S392. A Photographic Method of Detecting Changes in a Complicated Group of Objects.....*M. H. Stillman*

The method consists of the following procedure: Two negatives of the group of objects are made; one before the expected change, the other afterwards. A positive is printed from one of the negatives, is superposed in register upon the other negative, and the combination viewed against a light source. Portions of the combination corresponding to unchanged portions of subject will be of nearly uniform opacity, while changes will be revealed by marked variations in opacity. Factors of importance in the successful application of the method are discussed. Some useful applications of the method are suggested. (July 31, 1920.) 12 pp. Price, 5 cents.

S393. Measurements of Thermal Dilatation of Glass at High Temperatures.....*C. G. Peters and C. H. Cragoe*

The thermal dilatation of 32 different kinds of glass of known compositions was determined by the Fizeau interference method. Observations were made in the temperature region between 20° and 650° C. The dimensional changes are represented by curves which show that the glass passes through a critical expansion region in which the expansion rate increases by two to seven times. This critical region, which does not exceed 40°, was found as low as 400° with one glass and as high as 575° with another. About 75° above the critical region the glass softens and contracts. (August 20, 1920.) 39 pp. Price, 10 cents.

S394. Air Forces on Circular Cylinders, Axes Normal to the Wind, with Special Reference to Dynamical Similarity.....*Hugh L. Dryden*

An account of some tests in the Bureau of Standards wind tunnel of the commonly accepted air resistance equation, $R=PAV^2 f(VL/v)$, made on circular cylinders placed with their axes normal to the wind. It is found that the force on cylinders of diameter less than 3 inches does not satisfy the equation in so far as the variation of the force with size is concerned. The "guard ring" principle was used to obtain results applicable to cylinders of infinite length. Some measurements of the pressure distribution around cylinders were made. (Sept. 4, 1920.) 31 pp. Price, 5 cents.

S395. Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red Hardness.....*Howard Scott*

The physical changes accompanying the heat treatment of high-speed steel are studied and explanations offered of certain anomalies characteristic of this steel. The significance of the physical changes observed and their relation to the same phenomena in simple carbon steels are noted. (Sept. 16, 1920.) 16 pp. Price, 10 cents.

S396. Thermal and Physical Changes Accompanying the Heating of Hardened Carbon Steels.....
.....*Howard Scott and H. Gretchen Movius*

Thermal curves were taken on seven carbon steels to show the effect of rate of heating, treatment, composition, and microstructure on the temperature and nature of the heat evolution resulting from previous hardening. Important relations are pointed out between the characteristics of this transformation and the changes in several physical properties on tempering. (Sept. 20, 1920.) 20 pp. Price, 5 cents.

S397. A Study of the Relation between the Brinell Hardness and the Grain Size of Annealed Carbon Steels.....
.....*Henry S. Rawdon and Emilio Jimeno-Gil*

The Brinell hardness of five steels differing considerably in composition and in conditions representing wide variations in grain-size was measured to determine if possible the relation of this property to the grain-size. The grain-size was developed by annealing for 6-hour periods at various temperatures. A second method used of producing a coarse grain consisted in annealing the material at a relatively low temperature after it had received a preliminary cold-working. The results show that the grain-size is a factor of minor importance so far as Brinell hardness is concerned. The structure, which in turn depends upon the carbon content, and the rate of cooling of the specimen after annealing have far greater influence in this respect. (Sept. 20, 1920.) 37 pp. Price, 10 cents.

S398. Positive and Negative Photoelectrical Properties of Molybdenite and Several Other Substances ..... *W. W. Coblentz*

This paper gives a description of new observations on positive and negative spectrophotoelectrical reactions in molybdenite, silver sulphide, etc., as dependent upon temperature as well as magnitude and direction of the current through the crystal. It is shown that for radiation of wave lengths less than 0.7μ the photoelectrical reaction, in a certain sample of molybdenite, is positive or negative depending upon the magnitude and direction of the current through the crystal. In three appendices data are given (1) on a frequency relation in the sensitivity bands of molybdenite, (2) a survey of the general spectrophotoelectrical properties of substances, and (3), on thermal radiophonic signaling apparatus. (Oct. 11, 1920.) 45 pp. Price, 10 cents.

S399. Metallographic Etching Reagents: I, For Copper ..... *Henry S. Rawdon and Marjorie G. Lorentz*

In the study of the microstructure of metals, the etching of the specimen is of fundamental importance. In the study of the general subject by the Bureau of Standards, copper was the first type to be considered. The principles underlying the etching of this metal are developed and it is shown that oxidation is of prime importance. A list of typical etching reagents is given and the relative value of the various reagents is shown by means of numerous micrographs illustrating the etching of various forms in which copper occurs. (Oct. 14, 1920.) 28 pp. Price, 10 cents.

S400. Ionization and Resonance Potentials of Some Nonmetallic Elements..... ..... *F. L. Mohler and Paul D. Foote*

The resonance and ionization potentials of phosphorus, iodine, sulphur, nitrogen, oxygen, and hydrogen have been measured in four-electrode vacuum tubes by methods similar to those used previously by the authors. The results with hydrogen agree with the theoretical predictions of Bohr. (Oct. 14, 1920.) 32 pp. Price, 5 cents.

S401. Infra-Red Transmission and Refraction Data on Standard Lens and Prism Material.... *W. W. Coblentz*

Transmission curves of quartz, fluorite, rock salt, and sylvite, etc., are given, and the suitability of these substances for prisms, with especial reference to infra-red spectroradiometry, is discussed. Tabulated data are given of the refractive indices of these materials. The paper discusses also the construction and methods of calibration of spectroradiometers. (Oct. 27, 1920.) 14 pp. Price, 5 cents.

S402. Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel... *Henry S. Rawdon*

Ammonium persulphate is a widely used etching reagent for copper alloys but the advantages of its use with iron and steel have been almost entirely overlooked. The article describes the method of application of the reagent and gives photographs to illustrate typical results obtained. Ammonium persulphate decomposes upon the addition of water so that the action of the reagent is that of a weak acid intensified by the presence of oxygen. Chemical inhomogeneity is readily shown by the reagent but the most characteristic feature in its action is the readiness with which it reveals the crystalline condition of the material. (Nov. 12, 1920.) 9 pp. Price, 5 cents.

S403. Resonance Potentials and Low-Voltage Arcs for Metals of the Second Group of the Periodic Table. . *F. L. Mohler, P. D. Foote, and W. F. Meggers*

Measurement of potentials of inelastic impact by more sensitive methods than used in previous work show the existence of two resonance potentials in mercury, cadmium, zinc, and magnesium. By the quantum relation they correspond to the two spectral lines 1.5 $S-2p_2$ and 1.5 $S-2P$. A spectroscopic study of the low voltage arc in magnesium demonstrates the existence of the line 1.5 $S-2p_2$, $\lambda=4571$ A as the single line spectrum. (Nov. 17, 1920.) 13 pp. Price, 5 cents.

S404. The Magnetic Reluctivity Relationship as Related to Certain Structures of a Eutectoid-Carbon Steel. . . . . *C. Nusbaum, W. L. Cheney, and H. Scott*

The magnetic reluctivity relationship permits a study of the structure of a eutectoid carbon steel. This has been done for various heat treatments, viz., when quenched from 800° C in water and in oil and when drawn back to successively higher temperatures. In the range between the quenched condition and the drawing temperature, 230° C, the material which is in a martensitic condition appears to be magnetically nonhomogeneous as shown by a change of slope of the reluctivity line. This may be due to stresses in the material. Between the drawing temperatures 230° C and 470° C the material which is troostitic in structure is homogeneous, while beyond 470° C there again appears a distinct bend in the reluctivity line, indicating the presence of two magnetically different constituents. (Nov. 26, 1920.) 19 pp. Price, 5 cents.

S405. A Simple Portable Instrument for the Absolute Measurement of Reflection and Transmission Factors. . . . . *A. H. Taylor*

A small integrating sphere, with a small segment cut off, has been adapted for attachment to a portable photometer. The opening in the sphere is placed over the surface to be tested, so that the test surface completes the surface of the sphere. A small beam of light from a low-voltage lamp is projected through another small hole onto the test surface at an angle of about 40° from the normal. It can be rotated so that it is incident on the sphere surface at another point instead of the test surface. Photometer readings are taken with these two conditions, and the reflection factor of the test surface is the numerical value of the ratio of the brightness of the sphere wall in the two cases. (Nov. 30, 1920.) 6 pp. Price, 5 cents.

S406. Present Status of the Constants and Verification of the Laws of Thermal Radiation of a Uniformly Heated Inclosure. . . . . *W. W. Coblentz*

An examination is made of the instruments, methods, and experimental data pertaining to various determinations of the constant, σ, of total radiation and the constant, C, of spectral radiation of a black body. After making obvious corrections for reflection from the receiver and for atmospheric absorption, the determination of various experimenters are in close agreement, giving a value of $\sigma=5.72\times10^{-5}$ erg, and $C=14\ 320$ micron degrees. (Dec. 20, 1920.) 42 pp. Price, 10 cents.

S407. Recent Modifications in the Construction of Platinum Resistance Thermometers. . . . . *T. S. Sligh, Jr.*

A description of some recent modifications in platinum resistance thermometer construction which tend to improve the accuracy, to simplify, or to increase the robustness of the thermometers. Methods of annealing thermometers are discussed and some practical notes regarding the technique of resistance thermometer construction are given. A convenient and effective type of laboratory heating coil is described. (Jan. 5, 1921.) 15 pp. Price, 5 cents.

S408. Effect of the Rate of Cooling on the Magnetic and other Properties of an Annealed Eutectoid Carbon Steel.....*C. Nusbaum and W. L. Cheney*

Specimens of a eutectoid carbon steel were cooled from 800° C in air, in lime, and at various rates in a furnace. The effect of these rates of cooling on the magnetic properties, viz., maximum and residual induction, coercive force, permeability, and the magnetic reluctivity relationship, also on the resistivity and scleroscope hardness, are shown in tables and graphically and their significance discussed. Micrographs illustrating the structure are presented. It is shown that the change in structure from an essentially sorbitic one to "divorced" pearlite causes a gradual shifting of the bend in the reluctivity line and a greater difference between the values of the "real" and "apparent" saturation intensities. (Jan. 22, 1921.) 14 pp. Price, 5 cents.

S409. A New Method for the Measurement of Photographic Filter Factors.....*Raymond Davis*

A new method of measuring the factors by which the exposure on a color sensitive plate must be multiplied when the plate is used with a photographic filter. The apparatus consists of a photometer which receives light from two sides of the same light source and brings the two beams side by side on the photographic plate after one has passed through the color filter. The color of the gas filled tungsten lamp used is corrected to the spectral energy distribution of average noon sunlight. An illustration of a practical test is given; also experimental data demonstrating the accuracy of the method. (Feb. 5, 1921.) 11 pp. Price, 5 cents.

S410. Thermal Expansion of Copper and Some of its Important Industrial Alloys.....*Peter Hidnert*

Data on the thermal expansion of 128 samples of copper alloys of various compositions (56 to 100 per cent copper), heat treatments, mechanical treatments, etc., are presented.

Definite mathematical relations were found to exist between the instantaneous coefficients of expansion and the copper content of most of the alloys investigated. In general, the coefficient of expansion increases with a decrease in the copper content. The addition of lead or tin has a decided effect on the coefficient; the former element generally decreases and the latter increases the coefficient.

The effects of cold working were also studies. For example, the coefficients of cold rolled copper zinc alloys containing from about 62 to 90 per cent copper, are greater than the coefficients of corresponding castings. (Mar. 21, 1921.) 69 pp. Price, 25 cents.

S411. Wave Length Measurements in Arc Spectra Photographed in the Yellow, Red, and Infra-Red.. .....*F. M. Walters*

The arc spectra of silver, aluminum, gold, bismuth, cadmium, mercury, lead, antimony, tin, and zinc were photographed in the yellow, red, and infra-red on pinacyanol and dicyanin bathed plates with the aid of a large concave grating. Wave length measurements in international Angstrom units are given for waves longer than 5500 A, the spectral region under investigation extending from 5500 A to about 10 000 A. (Apr. 9, 1921.) 17 pp. Price, 5 cents.

S412. Spectrophotoelectrical Sensitivity of Proustite.... .....*W. W. Coblentz*

The present investigation is a continuation of previous work (See Sci. Papers Nos. 338, 344, 380, and 398) on the spectrophotoelectric sensitivity of various substances.

At 20° C the spectrophotoelectric sensitivity curve of proustite has a wide maximum in the ultra-violet with a weak ill-defined band at 0.61μ. At −170° C the intrinsic spectrophotoelectric sensitivity is greatly increased, and the maximum occurs at 0.578μ. (Apr. 9, 1921.) 8 pp. Price, 5 cents.

S413. A Portable Vacuum Thermopile.....*W. W. Coblentz*

A description is given of a vacuum thermopile container, rendered portable by attaching the calcium evacuator permanently to the receptacle. Directions are given for operating the device. The paper gives also some observations extending over a period of about 7 years, on the behavior of vacuum thermopiles in which the vacuum is maintained by means of calcium. (July 15, 1921.) 6 pp. Price, 5 cents.

S414. Interference Measurements in the Spectra of Argon, Krypton, and Xenon.....*W. F. Meggers*

The étalon-interferometer method for wave length comparisons is employed to measure the wave lengths for the stronger lines in the spectra of argon, krypton, and xenon. The values are determined relative to the wave length of the red radiation from cadmium (6438.4696 A), which is the international primary standard. Fifty argon wave lengths, 18 krypton, and 12 xenon are measured, most of which are probably correct to one part in several millions. The homogeneity and reproducibility of these lines makes them useful as secondary standards of wave length. Frequency differences of groups of lines in the spectra of argon and krypton are found to be constant within the probable error of the wave length measurements and the exactness of the combination principle of Ritz is thus verified. (Aug. 1, 1921.) 10 pp. Price, 5 cents.

S415. Use of the Ulbricht Sphere in Measuring Reflection and Transmission Factors.....*Enoch Karrer*

In this article a general survey is given of the theory and use of a hollow sphere in measuring the reflection factor of surfaces. The theory of the infinite luminous planes and instruments based upon them are also discussed. New absolute instruments for measuring the reflection and transmission factors are described in detail. (Aug. 10, 1921.) 23 pp. Price, 5 cents.

S416. Preparation of Galactose.....*E. P. Clark*

Owing to the large demand made by bacteriologists for specifications and data on galactose and its derivatives, a convenient method is described for preparing galactose from lactose so that this work may be undertaken.

One kilogram of lactose is hydrolyzed by boiling two hours with 2.5 liters of water and 50 grams of sulphuric acid. The solution is neutralized with barium carbonate, filtered and concentrated. The galactose is crystallized from the resulting sirup by the addition of a mixture of one part of ethyl and two parts of methyl alcohol. The yield of crude sugar is about 27 per cent of the lactose taken. (Aug. 15, 1921.) 3 pp. Price, 5 cents.

S417. The Spectral Distribution of Energy Required to Evoke the Gray Sensation.....*Irwin G. Priest*

The chief significance of this paper lies in the development and testing of an experimental method for determining an objective physical standard of "white light."

Experimental results are given from four observers. The average results of these observers indicate that "white light" may be represented: (1) Theoretically, by the light from a Planckian radiator at a temperature of 5200° absolute; (2) practically, to a fair approximation, by average noon sunlight at Washington. It is, however, emphasized that the final establishment of such a standard should be based on a more extensive statistical investigation.

An appendix to the paper sets forth the desirability of an extensive statistical determination and correlation of the characteristics of color vision. (Aug. 25, 1921.) 35 pp. Price, 10 cents.

S418. Spectroradiometric Investigation of the Transmission of Various Substances, II.... *W. W. Coblentz*

The paper (see S325 for similar data) gives transmission data in the spectrum extending from 0.6μ to 3μ, using a mirror spectrometer, a quartz prism, and a vacuum thermopile. The substances examined are a series of mineral, animal, and vegetable oils (containing fatty acids) nitrocellulose, bakelite, and selenite. It is shown that the absorption spectra of the oils are so nearly identical that they can not be used for detecting the adulteration of one oil with another. The paper concludes with an examination of the accuracy of the author's previous work using a rock salt prism. It is found that, using the recently determined refractive indices of rock salt, the corrections to the observations of 1903 to 1905 are of the order of 0.01μ to 0.02μ and hence negligible. (Aug. 29, 1921.) 10 pp. Price, 5 cents.

S419. The Production of Liquid Air on a Laboratory Scale..... *J. W. Cook*

The design and construction of laboratory apparatus for liquefying air by the Hampson process are described. Brief descriptions of necessary or useful accessories, such as purifiers for the air, precoolers, and a high-pressure needle valve are included. (Sept. 6, 1921.) 10 pp. Price, 5 cents.

S420. Specific Volume of Liquid Ammonia..... ..... *C. S. Cragoe and D. R. Harper*

The specific volume, that is, the numerical reciprocal of density, of pure liquid ammonia under the pressure corresponding to saturation conditions was determined throughout the temperature interval −78° to +100° C, with an accuracy of about 1 part in 10 000. A comprehensive review of previous work is included. Tables of specific volume and density in both metric and English units are appended. (Oct. 15, 1921.) 29 pp. Price, 5 cents.

S421. Wave Lengths Longer than 5500 A in the Arc Spectra of Yttrium, Lanthanum, and Cerium and the Preparation of Pure Rare Earth Elements. . *C. C. Kiess, B. S. Hopkins, and H. C. Kremers*

In Part I of this paper are given tables of wave lengths in the yellow, red, and infra-red regions of the arc spectra of yttrium, lanthanum, and cerium. Preparations of the rare earths made at the University of Illinois as well as imported materials were vaporized in the arc. The spectrograms measured were made with the concave grating spectrograph on plates sensitized with the dyes pinacyanol, kryptocyanin, and dicyanin. In all there were measured about 170 wave lengths in the spectrum of yttrium, 410 in the spectrum of lanthanum, and about 1700 in that of cerium. In Part II of the paper the methods used at the University of Illinois to purify the salts are described. (Oct. 14, 1921.) 35 pp. Price, 5 cents.

S422. Studies in Color Sensitive Photographic Plates and Methods of Sensitizing by Bathing..... ..... *Francis M. Walters, Jr., and Raymond Davis*

The dyes which are used in color sensitizing ordinary (blue sensitive) plates by bathing, require different methods for their most successful application. Pinaverdol, pinachrome, orthochrome T, and homocol may be used in water solutions, with or without ammonia, and are very little sensitive to electrolytes. Pinacyanol may be used in a water solution provided the plates are first thoroughly washed, but gives greater sensitizing action with more fog and poorer keeping quality when used with water, alcohol, and ammonia. Dicyanin gives comparatively little sensitizing except when used with water and alcohol and a fairly large per cent of ammonia.

Commercial panchromatic plates have their color sensitiveness increased by washing in water, without having the increase in fog which occurs when they are treated with ammonia. (Nov. 15, 1921.) 23 pp. Price, 15 cents.

S423. Operation of the Modulator Tube in Radio Telephone Sets.....*E. S. Purington*

The modulating device in radio communication varies the output current of a radio generator at a frequency lower than the radio frequency. This paper deals with the phenomena of modulation by speech in radio telephone transmitting sets employing electron tubes. A radio telephone transmitter is analyzed into four units—power supply, modulator unit, the generator unit, and the radiator unit. The essential operation and the limitations of the modulator unit are discussed. The strength of speech signals and power rating of radio telephone sets are discussed. (Nov. 15, 1921.) 30 pp. Price, 10 cents.

S424. Mathematical Theory of Induced Voltage in the High-Tension Magneto.....*Francis B. Silsbee*

Three different circuits representing in simplified form the essential features of the high-tension magneto are developed and equations for the electrical performance of each are given. It is shown that by the insertion of proper electrical constants in these equations the resulting performance will be substantially the same as that of an actual magneto. Methods are suggested for the experimental determination of these constants and the agreement between this theory and observed results as shown in certain cases. (Dec. 13, 1921.) 63 pp. Price, 15 cents.

S425. Characteristic Soft X-Rays From Arcs in Gases and Vapors.....*F. L. Mohler and Paul D. Foote*

Critical radiating potentials for 11 gases and vapors have been measured in a range from 17 to 500 volts. The spectrum range of limiting frequencies is from $\lambda=700$ to $\lambda=25$A.

The principal L series limits for sodium, magnesium, phosphorus, sulphur, and chlorine have been measured. A new softer L series for these elements is also indicated by the results. The K limits for carbon, nitrogen, and oxygen and the M limits for potassium have been measured.

Experiments on radiation from solids indicate that nearly pure characteristic effects with no measurable general radiation can be obtained under the best vacuum conditions. Results with nickel show radiation starting at 80 volts. (Dec. 17, 1921.) 26 pp. Price, 10 cents.

S426. Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel, and Aluminum.....
.....*Wilmer H. Souder and Peter Hidnert*

This paper gives data on the thermal expansion of 29 samples of commercial nickel, monel metal, stellite, stainless steel, and aluminum, and results obtained by previous observers on the expansion of nickel and aluminum. All of these materials except stainless steel (heated to 900° C) were examined from room temperature to about 600° C.

The results are presented in the form of tables and curves. The expansion curves of stellite show irregularities in the region between 300° and 500° C. For commercial nickel only a slight irregularity was perceptible at about 350° C.

For the range from room temperature to 100° C, the coefficients of expansion vary from 9.6×10^{-6} for a sample of hardened stainless steel to 23.8×10^{-6} for a sample of exceptionally pure aluminum. (Dec. 17, 1921.) 23 pp. Price, 10 cents.

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S427. Some Effects of the Distributed Capacity between Inductance Coils and the Ground..... *Gregory Breit*

When two condensers connected in series with common terminal grounded are connected across the terminals of an inductance coil as in the figure, their effective capacity in series is not equal to their effective capacity so far as resonance of the coil is concerned. If the capacity of one condenser is $\mathbb{C}_1$ and of the other $\mathbb{C}_2$, the quantity $\frac{\mathbb{C}_1\mathbb{C}_2}{\mathbb{C}_1+\mathbb{C}_2}$ is the effective capacity of the two condensers in series. As stated, it does not stay constant when $\mathbb{C}_1$ is changed arbitrarily and $\mathbb{C}_2$ is readjusted for resonance. A mathematical calculation shows, however, that provided the coil is symmetrical with respect to its two terminals the quantity $\frac{\mathbb{C}_1\mathbb{C}_2}{\mathbb{C}_1+\mathbb{C}_2}$ is linearly related to $\frac{1}{\mathbb{C}_1+\mathbb{C}_2}$. Experimental verification of this fact has been obtained. (Dec. 21, 1921.) 7 pp. Price, 5 cents.

S428. The Radio Direction Finder and Its Application to Navigation..... ..... *Frederick A. Kolster and Francis W. Dunmore*

The development of the radio direction finder, together with the radio fog-signaling system, has been undertaken by the Bureau of Standards, and in cooperation with the Bureau of Lighthouses extensive practical tests have been conducted.

The radio direction finder as a nautical instrument is completely described, and the results of experiments are given.

Three radio-signaling stations or radio beacons have been established at the entrance to New York. During fog, or at such times as may be necessary, these stations transmit their characteristic signals at frequent intervals. Ships equipped with radio direction finders can at such times take bearings on these stations and thereby proceed with safety.

The application of the direction finder to navigation and the establishment of fog-signaling stations at lighthouses and on board light vessels will result in more adequate protection to life and property at sea. (Jan. 16, 1922.) 38 pp. Price, 15 cents.

S429. Note on the Preparation of Mannose..... *E. P. Clark*

A method is described by which mannose may be prepared easily and economically. Ivory-nut shavings or sawdust are treated with dilute NaOH, washed, and dried. 500 grams of the material thus prepared are digested for a day with 75 per cent sulphuric acid, then dissolved in water to make 5.5 liters. This mixture is boiled for 2½ hours, neutralized with $BaCO_3$, concentrated, and the sugar crystallized from glacial acetic acid, giving a yield of 42 to 45 per cent of the treated meal. (Jan. 16, 1922.) 2 pp. Price, 5 cents.

S430. High-Frequency Resistance of Inductance Coils.. ..... *Gregory Breit*

The meaning of the term "resistance" needs careful consideration in the case of high-frequency alternating currents. Difficulties are caused by two effects—the skin effect and the capacity effect. Capacity effects in inductance coils, which are considered in this paper, are caused by the capacities which exist between different portions of the coil, and consist in the collection of charges at points on the wires of the coil, and in the nonuniform distribution of current in the coil which these charges cause. The measured resistance of an inductance coil assumes varying values, depending upon the point with respect to which it is measured. It is shown that if the resistance with respect to all points of the coil is known, then the current at any point of the coil may be computed as soon as the distribution of emf's along the coil is assigned, and a formula is derived for this purpose. Values of current computed by this formula are checked experimentally. The computed value of the resistance is also checked experimentally. (Feb. 24, 1922.) 19 pp. Price, 5 cents.

S431. The Field Radiated from Two Horizontal Coils.. ..... *Gregory Breit*

In order to facilitate the landing of airplanes, J. A. Willoughby, of the Bureau of Standards, devised a new type of radio transmitting antenna employing two horizontal coils. The behavior of this transmitting antenna is calculated in this paper. Expressions are derived for the current received in a coil antenna and in an open antenna located at a given distance from and in a given orientation with reference to the transmitting antenna. The variation of signal intensity is computed for the case of an airplane in horizontal flight over the transmitting station, and it is found that if the reception is by means of a vertical coil antenna, then a maximum signal is heard in a position in which the line joining the airplane with the transmitting antenna makes an angle of 35° with the vertical. (Mar. 10, 1922.) 18 pp. Price, 5 cents.

S432. An Improved Method for Preparing Raffinose.. *E. P. Clark*

Owing to the demands made by chemists and bacteriologists for specifications and standards for raffinose, a convenient and economical method for its preparation has been developed. Cottonseed meal is extracted from water, the liquor freed from impurities with basic lead acetate, and the raffinose present removed from the liquid as an insoluble lime compound. This raffinosate is decomposed with CO_2 and the free sugar resulting is crystallized from its concentrated sirup by means of alcohol. A device for carbonating, which is useful for many other purposes, is also described. (Apr. 8, 1922.) 4 pp. Price, 5 cents.

S433. Thermal Expansion of a Few Steels ....*Wilmer Souder and Peter Hidnert*

The critical regions of steel are used as a basis for heat treatment in securing or retaining desirable qualities, such as hardness, elastic properties, tensile strength, etc. Data are presented in tabular form and in curves showing the dimensional changes of steel in passing through these regions. Electrolytic iron and cast iron are also included. One specimen of hardened steel is analyzed, by dimensional changes, to show the release of strains on heating. (Apr. 10. 1922.) 16 pp. Price, 5 cents.

S434. Electromotive Force of Cells at Low Temperatures.. ..... *G. W. Vinal and F. W. Altrup*

The practical importance of a knowledge of the electromotive behavior of dry cells and storage batteries at low temperatures has arisen from their use in the Arctic and at high altitudes. Measurements were made on dry cells and storage batteries cooled to-72° C. by carbon dioxide snow and to-170° C. by the use of liquid air. The Gibbs–Helmholtz equation was applied to the observations and excellent agreement between theory and observation found. At the lowest temperatures high values of voltage were sometimes observed and the polarity often reversed. A possible explanation based on the Nernst equation is given. (Apr. 17, 1922.) 8 pp. Price, 5 cents.

S435. Metallographic Etching Reagents: II. For Copper Alloys, Nickel, and the Alpha Alloys of Nickel .....*Henry S. Rawdon and Marjorie G. Lorentz*

This investigation constitutes the second part of the general study of metallographic etching reagents. Specimens representative of all of the types of alloys in the copper-zinc system and of the industrial bronzes and of aluminum bronze were examined. The etching characteristics of brasses and bronzes are very similar to those of copper (S399) in that oxidation plays a very important part. Nickel is etched with very considerable difficulty, contrast is usually lacking, and pitting is apt to be execssive. A new reagent, concentrated hydrochloric acid, is described for etching this material, by means of which very superior results may be obtained. The alpha nickel alloys are etched much more readily than is the metal itself, particularly the nickel brasses. (Apr. 27, 1922.) 42 pp. Price, 15 cents.

S436. Interference Methods for Standardizing and Testing Precision Gage Blocks. . *C. G. Peters and H. S. Boyd*

With the interference methods described in this paper the planeness and parallelism errors of precision gage surfaces can be measured and the length of standard gages determined by direct comparison with the standard light waves with an uncertainty of not more than a few millionths of an inch. The errors of other gages can be determined by comparison with these calibrated standards, with equal precision. (May 2, 1922.) 37 pp. Price, 10 cents.

S437. The Solubility of Dextrose in Water. . . . . *Richard F. Jackson and Clara Gillis Silsbee*

The equilibria in the system, dextrose and water, have been determined. For temperatures below 90° C. three solid phases are capable of existence, namely, ice, α-dextrose monohydrate, and anhydrous dextrose. The cryohydric point lies at the temperature $-5.3°$ C. and concentration 31.7 per cent dextrose. The solid phase, α-dextrose, monohydrate, which occurs in lustrous plates, is stable between -5.3 and 50° C. Its solubility shows a very high temperature coefficient. The observed melting point, 80–90° C., although located far from the extrapolated solubility curve, is shown to be compatible with the measurements. The anhydrous form, stable above 50° C., has a small solubility temperature coefficient. The solubility measurements of this phase in metastable state were continued down to 28° C. (May 5, 1922.) 10 pp. Price, 5 cents.

S438. Tests of Stellar Radiometers and Measurements of the Energy Distribution in the Spectra of 16 Stars . . . . . *W. W. Coblentz*

An account is given (1) of the new tests of stellar radiometers, (2) of new measurements of the total radiation of stars, (3) of the spectral energy distribution in the complete spectrum of a star as determined by means of transmission screens, and (4) of estimates of the temperature of stars as determined from the spectral energy measurements. These radiation measurements indicate spectral energy distribution equivalent to that of a black body at 3,000° K for red stars to 10,000° K for blue stars. (May 12, 1922.) 26 pp. Price, 10 cents.

S439. Sensitometry of Photographic Emulsions and a Survey of the Characteristics of Plates and Films of American Manuafcture. . . . . *R. Davis and F. M. Walters, jr.*

The properties of photographic emulsions are discussed from the standpoint of the relation between density and expsoure, the growth of contrast with development, color sensitiveness, resolving power, and fogging in development. The apparatus used in testing photographic material at the Bureau of Standards is described. Charts are given of 90 negative emulsions made in the United States. These charts show the characteristic curves, the rate of development curve, the growth of fog with contrast, the color sensitiveness, the filter factors, the speed, the resolving power, and scale of the various plates and films. (May 5, 1922.) 120 pp. Price, 35 cents.

S440. The Spectral Transmissive Properties of Dyes: I. Seven Permitted Food Dyes, in the Visible, Ultra-Violet, and Near Infra-Red..... *K. S. Gibson, H. J. McNicholas, E. P. T. Tyndall, M. K. Frehafer, and W. E. Mathewson*

In this paper is presented the outline of an investigation of the spectral transmissive properties of dyes. The plans and purposes of this investigation are discussed, the methods and apparatus used to obtain the data described, and a tentative nomenclature presented. Four methods are used in the experimental work (1) the visual method, using the König-Martens spectrophotometer; (2) the photographic method, with the Hilger sector photometer; (3) the photoelectric null method; and (4) the thermoelectric method. The total range of measurement is from 240 to 1,360 millimicrons.

As a beginning, and to illustrate the methods of obtaining and presenting the data, the transmittances of seven permitted food dyes have been obtained in the visible, ultra-violet, and near infra-red spectral regions, at different concentrations, thicknesses, and temperatures. Discussion of the analytical and theoretical applications of the data is postponed until more data are available. (May 15, 1922.) 64 pp. Price, 15 cents.

S441. Notes on Standard Wave Lengths, Spectographs, and Spectrum Tubes..... .....*W. F. Meggers and Keivin Burns*

I. Standard wave lengths in the cadmium spectrum are presented in the range 2980 to 5085 A. The values for 13 lines are given relative to the primary standard and are thought to be correct to one part in several millions.

II. A quartz rock salt spectograph designed for the purpose of photographing interference phenomena in the ultra-violet is described.

III. The characteristics and performance of a stigmatic concave grating mounting are outlined, and detailed drawings of the apparatus are reproduced.

IV. Instructions and suggestions are given for the preparation of spectrum tubes commonly required for optical demonstration, testing, or research. (May 24, 1922.) 15 pp. Price, 5 cents.

S442. Wave-Length Measurements in the Arc Spectra of Neodymium and Samarium.....*C. C. Kiess*

This paper contains about 3,000 wave lengths measured in the arc spectra of neodymium and samarium between 5475 A in the green and 9200 A in the infra-red. A supplementary list contains about 125 lines common to the spectra of both elements. They may be characteristic of the element coming between neodymium and samarium, but not yet isolated. A large concave grating spectograph was used for the work, the photographic plates being suitably sensitized for the regions investigated. The materials used were neodymium oxalate and samarium oxide prepared at the University of Illinois and samarium oxalate prepared at New Hampshire College. (June 1, 1922.) 19 pp. Price, 5 cents.

S443. Measurement of the Color Temperature of the More Efficient Artificial Light Sources by the Method of Rotary Dispersion.....*Irwin G. Priest*

A description of measurements of color temperature by the method of rotary dispersion for color temperatures between 3,000 and 4,000° absolute centigrade. Quantitative data are given on (1) comparison of color temperature scales at the Bureau of Standards and the Nela Research Laboratory, (2) the color temperature of the gas-filled tungsten lamp as a function of efficiency up to the melting point of tungsten, and (3) the color temperature of the carbon arc. (July 24, 1922.) 14 pp. Price, 5 cents.

S444. Practical Spectrographic Analysis.....*W. F. Meggers*

A brief review of various methods which have been proposed for chemical analyses by means of the spectrum is followed by a detailed description of the principle, apparatus, and procedure employed in making quantitative analyses from the spectra of condensed sparks. The practical application of this method is illustrated by three samples taken from the work of the spectroscopy section of the Bureau of Standards and deals with the quantitative determination of impurities in various samples of tin, gold, and platinum. Other applications to problems in chemistry, metallurgy, mineralogy, physics, biology, etc., are suggested. (July 29, 1922.) 21 pp. Price, 10 cents.

S445. A Piezo Electric Method for the Instantaneous Measurement of High Pressures.....*J. C. Karcher*

A number of quartz plates suitably cut are arranged, condenser fashion, in a stack and introduced in an electric circuit. The quartz plates are subjected by means of a piston to the gas pressure to be measured. The combination of these constitutes a gauge which is screwed into the wall of the gas chamber, and the leads are brought out through holes drilled through the wall. A ballistic galvanometer whose period is long compared to the duration of the pressure phenomenon is connected to the electrodes of the quartz plates. The galvanometer deflections are photographically recorded on a rapidly moving film. The pressure-time curve is the differential of the recorded deflection-time curve. (Aug. 4, 1922.) 8 pp. Price, 5 cents.

S446. Spectrophoto-electrical Sensitivity of Argentite... .....*W. W. Coblentz*

The present paper on argentite (isometric crystal) in connection with a previous paper (B. S. Sci. Paper No. 344) on acanthite (orthorhombic crystal) constitutes a study of spectrophoto-electrical sensitivity as affected by crystal structure. The paper gives experimental data on the effect of temperature, of the intensity of the radiation stimulus, and of mechanical working of the material upon photo-electrical sensitivity. From the data presented it is concluded that crystal structure has a marked effect upon spectrophoto-electrical sensitivity. (Aug. 18, 1922.) 16 pp. Price, 5 cents.

S447. Theory, Construction, and Use of the Photometric Integrating Sphere.....*E. B. Rosa and A. H. Taylor*

Part I deals with the materials and construction of various spheres, and describes in detail the construction of a reinforced concrete sphere at the Bureau of Standards. It gives tests of the accuracy of integration by this sphere, the absorption of light by the sphere coating and by objects in the sphere, and the effect of the position of lamps. Proper methods of operation are also outlined.

Part II gives a fairly complete résumé of the general theory of the sphere, with the addition of a considerable amount of new material, showing how to test the accuracy of the sphere, and how to improve the accuracy of integration. It also gives a bibliography of the subject. (Aug. 28, 1922.) 45 pp. Price, 10 cents.

S448. The Decarburization of Ferrochromium by Hydrogen.....*Louis Jordan and F. E. Swindells*

The recent development of stainless or rustless iron—a very low-carbon stainless steel—has emphasized the demand for inexpensive, low-carbon ferrochromium. Methods of refining high-carbon ferrochromium are reviewed. Several investigations of the decarburization of iron and steel by heating in hydrogen have been reported in the literature. A similar method for the decarburization of high-carbon ferrochromium has been proposed. Decarburization takes place slowly when solid ferrochromium is heated in hydrogen at or above 1,100° C. The most rapid decarburization was secured by blowing hydrogen through molten ferrochromium. (Sept. 15, 1922.) 8 pp. Price, 5 cents.

S449. Radio-Frequency Amplifiers..... *P. D. Lowell*

The use of radio-frequency amplification makes it possible to receive very feeble signals which without such amplification can not be heard at all. For satisfactory reception with coil antennas, such as those used in direction-finding work, radio-frequency amplification is necessary. There are three important methods by which the stages of a radio-frequency amplifier may be coupled—resistance coupling, tuned-plate coupling, and transformer coupling. This paper discusses each of these methods, particularly the last method, and gives circuit diagrams and constructional details. The construction of the radio-frequency transformers and other accessory devices required in constructing the amplifier is described. Descriptions are given of radio-frequency transformers having iron cores of thin steel laminations, as well as air-core transformers. (Oct. 2, 1922.) 9 pp. Price, 5 cents.

S450. An Electron-Tube Amplifier Using Sixty-Cycle Alternating Current to Supply Power for the Filaments and Plates..... *P. D. Lowell*

Electron-tube amplifiers now form an important part of practically all radio-receiving sets. The usual types of electron-tube amplifiers in general use require storage batteries and dry batteries to supply power. This paper describes the development of a special type of amplifier which uses 60-cycle alternating current from the ordinary lighting mains as a source of power for both the filaments and plates. The final form of the amplifier has three stages of radio-frequency amplification—a crystal detector and two stages of audio-frequency amplification. The inconvenience and expense of storage batteries and dry batteries are eliminated. Complete circuit diagrams are given. (Oct. 2, 1922.) 8 pp. Price, 5 cents.

S451. Spectrophoto-electrical Sensitivity of Bournonite and Pyrargyrite.... *W. W. Coblentz and J. F. Eckford*

The present paper in connection with previously published data on proustite (Sci. Paper No. 412) represents a study of the effect of chemical constitution upon spectrophoto-electrical sensitivity. Experimental data are given on the effect of temperature and of the intensity of the radiation stimulus upon the spectrophoto-electrical sensitivity of bournonite and pyrargyrite. The results obtained are in agreement with the previously formulated (Sci. Paper No. 398) general characteristics of spectrophoto-electrical conduction in solids. (Oct. 3, 1922.) 20 pp. Price, 10 cents.

S452. The Structure of Martensitic Carbon Steels and the Changes in Microstructure which Occur upon Tempering..... *Henry S. Rawdon and Samuel Epstein*

A study of the microstructural changes produced in hardened steels by tempering was carried out in a series of six carbon steels (0.07 to 1.12 per cent carbon). The characteristic features in the visible structure of martensite are discussed, and the changes caused by heating are considered with reference to the thermal transformation in hardened steels which occurs at approximately 250° C. The microscopic study was supplemented by determinations of the scleroscope hardness, and the results were found to confirm and support the conclusions which the study of the structure appeared to warrant. (Oct. 9, 1922.) 37 pp. Price, 15 cents.

S453. The Preparation and Properties of Pure Iron Alloys: I. Effects of Carbon and Manganese on the Mechanical Properties of Iron..... ..... *Robert P. Neville and John R. Cain*

This paper describes the preparation and mechanical properties of a series of very pure alloys of electrolytic iron, carbon, and manganese, whose compositions were so chosen as to bring out the specific effects on pure iron of additions of carbon, additions of manganese, and additions of carbon and manganese together in varying relative proportions. The maximum content each of carbon and manganese is about 1.5 per cent; the minimum, 0 per cent, or pure iron. Three-pound ingots of the alloys were made by fusion under vacuum in an electric furnace. From these ingots test specimens were made and tested in the annealed state. The influence of carbon and manganese on the mechanical properties of the alloys is shown by curves. (Oct. 16, 1922.) 33 pp. Price, 10 cents.

S454. The Action of Charred Paper on the Photographic Plate and a Method of Deciphering Charred Records..... *Raymond Davis*

A method is given for obtaining a copy of the written and printed matter on paper records that have been charred. The charred paper is placed between two fast photographic plates and kept in total darkness for one or two weeks. On development in the usual manner a copy is obtained of the ink writing and printing. It appears that the gases from the charred paper have the property of fogging the plate, the ink acts as a screen, hindering the escape of the gases. (Oct. 18, 1922.) 6 pp. Price, 5 cents.

S455. Tables for the Calculation of the Inductance of Circular Coils of Rectangular Cross Sections..... *Frederick W. Grover*

Formulas for the calculation of inductance are usually rather complicated, and computations are tedious and time consuming. Furthermore, the choice of the proper formula for a given problem is often difficult. When many calculations have to be made, tables for facilitating the calculations are practically indispensable. This paper presents tables, based on accurate known formulas, for the calculation of inductance in the very important case of circular coils of rectangular cross section. By their aid the computation of the inductance is reduced to the simplest arithmetical operations. The method of using the tables is thoroughly explained and illustrated by examples. (Oct. 28, 1922.) 37 pp. Price, 10 cents.

S456. Spectrophoto-electrical Sensitivity of Some Halide Salts of Thallium, Lead, and Silver..... .....*W. W. Coblentz and J. F. Eckford*

The present paper, in connection with other papers (Sci. Papers Nos. 451 and 462), completes a study of the effect of crystal structure, chemical constitution, and atomic weight upon photo-electrical reaction spectra. Spectrophoto-electrical sensitivity data are given on the chloride, bromide, and iodide of thallium and of silver, and the iodide of lead. The photo-electrical reaction of these salts is confined to a very narrow region of the violet end of the spectrum. The effect of increasing the atomic weight of the acid element is to shift the maximum of the photoelectrical reaction toward the long wave length. (Nov. 8, 1922.) 10 pp. Price, 5 cents.

S457. Gases in Metals: I. The Determination of Combined Nitrogen in Iron and Steel and the Change in Form of Nitrogen by Heat Treatment.....*Louis Jordan and F. E. Swindells*

The nitrogen determined by the Allen method in iron alloys is that present as combined or nitride nitrogen. This method of analysis is described, and sources of errors are discussed. An increase in the amount of combined nitrogen was found to occur with heat treatment of certain irons and steels. It is probable that this increase in combined nitrogen is the result of the conversion of uncombined nitrogen to nitride nitrogen by heat treatment, and that nitrogen in two forms was originally present in the samples in which the increase took place. (Nov. 8, 1922.) 13 pp. Price, 5 cents.

S458. Apparatus for the Determination of the Magnetic Properties of Short Bars.....*M. F. Fischer*

This paper describes the method and apparatus developed for the magnetic testing of cylindrical samples 6 mm in diameter and 10 cm in length. The method consists of a comparison of the test sample with a reference bar whose properties have been previously determined by calibration. The induction is measured by a test coil surrounding the specimen. The magnetizing force for any induction is that indicated by the corresponding induction in the reference bar and is read from the calibration curve. Values of magnetizing force corresponding to a given induction can, in general, be measured to within 5 per cent of the correct value for most materials. (Nov. 15, 1922.) 14 pp. Price, 5 cents.

S459. The Structure of Fucose.....*E. P. Clark*

The complete structure of fucose has not hitherto been known, the position of the hydroxyl group on carbon atom 5 being the part in doubt. In order to clear up this point, a lactone of the methyl tetronic acid has been prepared, and from its optical properties the position of the hydroxyl group on carbon atom 4 of this substance, corresponding to carbon atom 5 of fucose, has been established, thus giving the complete structure of fucose. The position of the hydroxyl groups on carbon atoms 2, 3, and 4 of fucose has also been verified by a study of the optical properties of the amides of the methyl tetronic acid and of fuconic acid (prepared for the first time), together with fuconic lactone. An improved method for preparing fucose is also recorded. (Nov. 22, 1922.) 8 pp. Price, 5 cents.

S460. Further Tests of Stellar Radiometers and Some Measurements of Planetary Radiation.....
.....*W. W. Coblentz*

Improvements are described in the radiometric apparatus used in measuring the radiation from celestial objects. Data are given on the radiations emitted by planets due to warming by solar radiation and due to a possible high internal temperature; also a verification of the stellar temperatures by means of transmission screens described in B. S. Sci. Papers, No. 438. The intensity of the planetary radiation, in per cent of the total radiation from a planet, is as follows: Jupiter (0), Venus (5), Saturn (15), Mars (30), and the moon (80).

The measurements obtained on the sun verify previous data indicating stellar temperatures ranging from 3,000° K for red, class M stars, to 12,000° for blue, class B stars. (Dec. 23, 1922.) 24 pp. Price, 10 cents.

S461. Spherical Aberration of Thin Lenses...*T. Townsend Smith*

This article presents the elementary theory of thin lenses, gives means for determining quickly the aberration of any thin lens for any position of the object and formulates conditions under which spherical aberrations of two thin lenses will compensate one another. A graphical solution of the problem as to the conditions under which a two-piece lens may be achromatic, free from axial spherical aberration and free from coma is included, and the shapes of lenses necessary to satisfy these different conditions are shown. (Dec. 27, 1922.) 26 pp. Price, 10 cents.

S462. Various Photo-electrical Investigations....*W. W. Coblentz*

Data are given upon: (1) The photo-electrical sensitivity of artificial preparations of molybdenum sulphide; (2) the effect of heat and electrical treatment upon the photo-electrical sensitivity of molybdenite and stibnite; (3) various artificial preparations; (4) positive and negative photosensitivity; (5) spectral response curve of Case's barium and strontium photo-electric cells; also of cuprous oxide, of lead antimony sulphide and of iodine; and (6) spectroscopic and chemical analyses of photosensitive and nonsensitive molybdenite. (Dec. 27, 1922.) 23 pp. Price, 10 cents.

S463. Preparation and Properties of Pure Iron Alloys: II. Magnetic Properties of Iron-Carbon Alloys as Affected by Heat Treatment and Carbon Content.....*W. L. Cheney*

A study of the variations of the magnetic properties of unusually pure iron-carbon alloys due to (1) heat treatment, viz, (*a*) hardening by quenching from temperatures above the critical range, and then drawing back to successively higher temperatures, (*b*) carefully annealing in vacuo; and (2) carbon content. The hardened alloys show certain magnetic transformations when drawn back to higher temperatures, which correspond to metallographic transformations. Comparing the magnetic properties with the carbon content, there are found certain changes in these properties as the percentage of carbon content is increased. The reluctivity relationship is employed to predict the number of metallographic constituents present in the material. (Dec. 27, 1922.) 27 pp. Price, 15 cents.

S464. Preparation and Properties of Pure Iron Alloys: III. Effect of Manganese on the Structure of Alloys of the Iron-Carbon System.....
.....*Henry S. Rawdon and Frederick Sillers, jr.*

Manganese plays at least three rôles in carbon steels, as deoxidizer, "desulphurizer," and as a hardener. This investigation deals with the third. The effect of manganese upon the structure was determined for an extensive series of alloys, C, 0 to 1.6; Mn, 0 to 2 per cent. The general effect of manganese may be described as a "restraining influence," so that even after annealing, steels have the structure and properties ordinarily found in similar steels of low manganese content after more rapid cooling. Manganese confers upon pearlite a fine grained sorbitic structure and lowers the eutectoid ratio by approximately 0.12 per cent for each per cent of added manganese. After normalizing, specimens high in manganese were much finer grained than those low in manganese; no difference in the annealed specimens was noted, however. (Dec. 27, 1922.) 17 pp. Price, 10 cents.

S465. Composition, Purification, and Certain Constants of Ammonia.....*E. C. McKelvy and C. S. Taylor*

Chemical tests made on eight standard American brands of commercial ammonia indicate that most commercial brands contain less than 0.1 per cent of impurities. Choosing the best commercial samples as a starting point for further purification, 15 samples were prepared, by numerous fractional distillations, for use in the determination of the various thermodynamical properties of ammonia. These samples were found to contain less than 0.01 per cent, by weight, of water from approximately 1 part in 10,000 to 1 part in 1,000,000, by volume, of noncondensing gases, and less than 0.001 per cent of other impurities. Determinations were made of the density of the solid, freezing point, and vapor pressure at the triple point. (Mar. 9, 1923.) 39 pp. Price, 10 cents.

S466. Wave Length Measurements in the Arc Spectra of Gadolinium and Dysprosium.....*C. C. Kiess*

Very pure gadolinium oxide and dysprosium oxalate prepared at the University of Illinois were used in studying the arc spectra of these elements from the green (5500A) out into the infra-red spectral regions. About 950 lines belonging to Gd and about 800 belonging to Dy have been tabulated. Most of these lines are faint. A band spectrum is emitted faintly by each element. (Mar. 12, 1923.) 12 pp. Price, 5 cents.

S467. Specific Volume of Saturated Ammonia Vapor ....*C. S. Cragoe, E. C. McKelvy, and G. F. O'Connor*

This paper describes the measurement of the specific volume of ammonia vapor under saturation conditions in the temperature interval −50 to +50° C. by two methods—one, involving a direct determination of the mass of the vapor contained in a known volume; and the other, an optical method, involving measurements of the index of refraction of the vapor. The experimental results are shown to be in fair agreement with values obtained by computation from other measured thermodynamic properties of ammonia. Tables in both metric and English units are appended. (Mar. 17, 1923.) 29 pp. Price, 5 cents.

S468. Formulas and Tables for the Calculation of the Inductance of Coils of Polygonal Form .....*Frederick W. Grover*

Inductance coils wound on forms such that each turn of the coil incloses a regular polygon have the advantage that, on account of the small amount of dielectric necessary for the support of the wires, energy losses in the dielectric may be made very small. In this paper formulas are derived for the calculation of the inductance of such coils, both for a single layer winding and for a multilayer winding. Tables which give the radius of a circular coil having the same inductance as the given polygonal coil are included. These enable the calculation of the inductance to be carried out by means of the existing formulas and tables for circular coils. (May 3, 1923.) 26 pp. Price, 10 cents.

S469. Directive Radio Transmission on a Wave Length of 10 Meters..... .....*Francis W. Dunmore and Francis H. Engel*

Two important means of reducing interference in radio communication are the use of short wave lengths, such as 10 m, and the use of directive types of antennas which will direct a beam of radiated waves toward the receiving station with which it is desired to communicate. Experiments embodying both of these methods have been conducted at the bureau with an electron-tube transmitting set and a directive reflecting antenna, consisting of short vertical wires arranged as the elements of a parabolic cylinder, using a wave length of 10 m. Each of the vertical wires was tuned separately to the radiated wave length, and the source was placed at the focus of the parabola. The radiated wave was found to be confined to an angle of about 40°. The paper gives construction details concerning the apparatus and circuits used, so that anyone may duplicate the results described. (Apr. 11, 1923.) 16 pp. Price, 10 cents.

S470. A Method for the Accurate Measurement of Short-Time Intervals..... .....*Harvey L. Curtis and Robert C. Duncan*

A method is described whereby small intervals of time between events, whose occurrence can be recorded on a moving photographic film, may be determined with a high degree of accuracy. The method consists in ruling on the moving film a uniform time scale, simultaneously with the recording of the events to be studied. The time scale is obtained by throwing flashes of light on the film from a shutter controlled by a tuning fork. The paper discusses in considerable detail the type of optical system used, the necessary conditions for the most satisfactory timing lines, the sources of error inherent in the method, and the accuracy with which various time intervals can be measured. (Apr. 26, 1923.) 22 pp. Price, 10 cents.

S471. Methods of Measurement of Properties of Electrical Insulating Materials..... .....*J. H. Dellinger and J. L. Preston*

The Bureau of Standards has received frequent requests for information on the methods that have been found practicable in making measurements of properties of electrical insulating materials. This paper describes the various methods in use at the bureau. They include phase difference and dielectric constant, voltage effects at radio frequencies, electrical resistivities, density and moisture absorption, tensile strength, transverse strength, hardness, impact strength, permanent distortion, machining qualities, thermal expansivity, and effects of chemicals. (May 2, 1923.) 34 pp. Price 15 cents.

S472. Alternating-Current Resistence and Inductance of Single-Layer Coils .....*C. N. Hickman*

Formulas for the alternating-current resistence and inductance of single-layer coils are developed by use of an integral equation method. The formulas are applied to coils in which the skin effect is quite pronounced. The resistance and inductance of the coils are measured at several frequencies, and the results compared with the computed values. A simple formula for the mutual inductance of coaxial circles of the same diameter is also developed. (May 3, 1923.) 32 pp. Price, 10 cents.

S473. A Method for the Measurement of Sound Intensity .....*J. C. Karcher*

A sound-detecting device, such as a magnetophone or electrostatic transmitter, and two coils, whose mutual inductance can be varied by known amounts, constitutes a measuring instrument. The sound detector and one coil are connected to an indicating instrument, consisting of a vacuum-tube amplifier, a rectifier, and galvanometer. The emf generated in the detecting instrument is compared by substitution with emf generated in one coil when the other carries a known current. Since the sound intensity is proportional to the square of the emf generated in the detector, a means of making sound intensity measurements is presented. The necessity for the calibration of an amplifier is obviated. The instrument has a sensitivity range of about a millionfold. (May 7, 1923.) 7 pp. Price, 5 cents.

S474. Series in the Arc Spectrum of Molybdenum..*C. C. Kiess*

Analysis of the arc spectrum of Mo reveals the fact that the stronger lines belong to triplets and multiplets. The triplets have been arranged into series, and formulas of the Ritz type have been found for them. From the series limits have been calculated the resonance and ionization potentials which are of importance in certain physical and astronomical problems. The multiplets consist of 9 and 13 lines, and have been found to arise from interorbital transitions of the valence electron similar to those which result in the emission of the triplet series. (July 10, 1923.) 17 pp. Price, 10 cents.

S475. The Visibility of Radiant Energy ....*K. S. Gibson and E. P. T. Tyndall*

In cooperation with the Nela Research Laboratories a new determination of the visibility of radiant energy has been made by the step-by-step method, an equality-of-brightness method with little or no hue difference in the photometric field. Fifty-two observers were used, some of them common to previous investigations. The final values are similar to those obtained by other investigators. There seems to be no certain difference between the values of visibility obtained by the flicker and equality-of-brightness methods, provided the former is used under conditions as recommended by Ives and the latter does not depart too widely from these conditions. A revision of the I. E. S. mean curve is proposed which results in better agreement with the average experimental visibility data. (Aug. 11, 1923.) 61 pp. Price, 15 cents.

S476. A Study of Radio Signal Fading.....
.....*J. H. Dellinger, L. E. Whittemore, and S. Kruse*

One of the difficulties encountered in radio communication at very high wave frequencies or short wave lengths, is the so-called fading of the received signals. This paper describes some tests which were made by the Bureau of Standards in cooperation with the American Radio Relay League. The observations reported by a large number of observers were analyzed and conclusions drawn as to possible relations between weather conditions and the fading and intensity of radio signals. The reports also included notes regarding the intensity of strays or atmospheric disturbances. (Sept. 25, 1923.) 40 pp. Price, 10 cents.

S477. Spectroradiometric Analysis of Radio Signals....
.....*Chester Snow*

If a radio signal is repeated at regular intervals, it will produce in a simple receiving circuit a current whose effective value may be measured. By varying the capacity in this circuit, it may be tuned successively to all frequencies within a given range, and the induced current observed. Since the circuit responds not to one frequency alone, but in varying degrees to all frequencies in a certain interval, there is some confusion in the record, caused by this overlapping. This article shows how to derive from such a record the spectral distribution of energy in the incoming wave. The method will be useful in studying the radiation actually sent out by a radio station in order to determine its interference producing qualities. (Oct. 22, 1923.) 32 pp. Price, 10 cents.

S478. Redetermination of Secondary Standards of Wave Length From the New International Iron Arc.....*W. F. Meggers and C. C. Kiess*

Important changes in the international iron arc as a source of standard wave lengths made it desirable to redetermine the system of standards. Accordingly, 84 of the international secondary standards (3370 to 6678A) have been remeasured in terms of the wave length of the red radiation from cadmium which defines the unit of wave length. In addition, 75 other lines have been measured in order to have standards at somewhat closer intervals. Twenty-three lines known to be sensitive to pressure have somewhat smaller values when the length of the arc is increased from 6 to 12 mm. Furthermore, the new values for the so-called stable lines deviate systematically from the internationally adopted values. The latter are believed to be slightly in error. (Jan. 5, 1924.) 10 pp. Price, 5 cents.

S479. Interferometer Measurements of the Longer Waves in the Iron Arc Spectrum.....
.....*W. F. Meggers and C. C. Kiess*

No extensive interferometer comparisons of iron arc wave lengths with the primary standard, the red radiation from cadmium, existed for waves longer than 6750A. A set of 161 values extending from 5534.525A to 8824.238A, 75 of which are longer than 6750A, is here presented. The probable error of each value is of the order of 0.001A. In the region in which these determinations overlap the international secondary standards there is a systematic difference indicating that the accepted international scale is nearly 1 part in 1,000,000 too large. (Jan. 5, 1924.) 8 pp. Price 5 cents.

S480. A Directive Type of Radio Beacon and its Application to Navigation. . *F. H. Engel and F. W. Dunmore*

The crossed-coil antenna directive radio beacon is described and an account of its experimental development given. The apparatus consists of an ordinary radio transmitting set coupled to two coil antennas so that signals are alternately transmitted from each coil antenna. The coils are crossed at an angle with respect to each other and, owing to the radiation characteristic of the coil antennas, a receiving set located on a line which bisects the angle between the coils receives signals of equal intensity from each coil antenna. At any point not on this line signals of unequal intensity are received, the difference in intensity being dependent on the location of the receiving set. When used as a beacon the ship or aircraft maintains its course by so navigating that the signals received from each coil are of equal intensity. (Jan. 5, 1924.) 15 pp. Price, 5 cents.

S481. Measurement of Low Resistance by Means of the Wheatstone Bridge. . . *Frank Wenner and Alva Smith*

A procedure is described for measuring resistances as low as 0.01 ohm or even 0.001 ohm by means of a Wheatstone bridge and the usual accessory apparatus. With a bridge in good adjustment and having a ratio arm which can be set as low as 0.1 ohm, an accuracy of 0.1 per cent or better may be obtained in the measurement of resistance as low as 0.001 ohm. (Jan. 11, 1924.) 9 pp. Price, 5 cents.

S. 482. Gravitational Anisotropy in Crystals . . . . . *Paul R. Heyl*

An experimental test of the fundamental postulate underlying Einstein's theory of gravitation, which asserts the indentity of gravitation and inertia. The most likely place to find gravitational variation would be in a crystal, by weighing it in different axial positions with respect to the earth. The results are negative, to a precision of 1 part in 10^9, and to this extent support Einstein's position. (Feb. 16, 1924.) 18 pp. Price, 10 cents.

S483. Investigations on the Platinum Metals. IV. Determination of Iridium in Platinum Alloys by the method of Fusion with Lead. . . . . *Raleigh Gilchrist*

The method, originally proposed by Deville and Stas, consists of fusion of the platinum alloy with excess of lead, disintegration of the resulting button with nitric acid, followed by treatment with dilute aqua regia to separate the soluble lead-platinum alloy from the insoluble iridium. A critical study of this method was made, using synthetic alloys with iridium content from 0.1 to 20 per cent. Experiments were made to determine the minimum time required for the fusion as well as the optimum temperature, the best proportion of lead, the error due to the solution of iridium by the aqua regia, and the effect of the presence of rhodium, palladium, ruthenium, and iron. (Feb. 28, 1924.) 21 pp. Price, 5 cents.

S484. Preparation and Properties of Pure Iron Alloys. IV. Determination of the Critical Ranges of Pure Iron-Carbon Alloys by the Thermoelectric Method. . . . . *J. F. T. Berliner*

This paper is an extension of the work (Scientific Papers 453, 463, 464) on the Thermoelectirc Measurement of the Critical Ranges of Pure Iron. The apparatus and procedure were practically the same as in the previous work. The material was an exceptionally pure series of iron-carbon alloys prepared at this bureau. This method affords a very accurate means of studying the critical ranges of iron and steel. The results show that the A_2 transformation is constant for heating and cooling up to a concentration of 0.45 per cent carbon and the temperature of the A_3, A_2, and A_1 transformations are in agreement with those obtained by other methods. (Mar. 5, 1924.) 10 pp. Price, 5 cents.

S485 Application of the Interferometer to Measurements of the Thermal Dilation of Ceramic Materials . . . . . *G. E. Merritt*

An interference method and apparatus for measuring the thermal expansion of ceramic materials are described. This method, which required samples from 0.5 to 10.0 mm in length is particularly applicable when only small fragments of the material are obtainable. Measurements made on the thermal expansion of several samples of glaze, terra cotta, tile, porcelain, and clay show that this method gives accurate and reproducible results. The results represented by curves show that the expansivities of difference of ceramic materials may differ greatly, that the expansion of a given material may be different at different parts of the temperature scale, and that some materials may undergo permanent dimensional changes when subjected to heat treatment. (Mar. 7, 1924.) 17 pp. Price, 5 cents.

S486. Some New Thermoelectrical and Actinoelectrical Properties of Molybdenite . . . . . *W. W. Coblentz*

The first part of the paper gives data on the thermoelectric power of molybdenite. The values range from about +700 mv, through practically zero thermal emf, to −1,040 mv.

An investigation is made of a newly observed actinoelectrical emf as affected by temperature, intensity of the spectral radiation stimulus, etc. A comparison is made of the spectral actinoelectric action which is observed without an impressed emf, and of the spectrophotoelectrical resistance change which is observed with an external battery. Among the newly observed phenomena is an amplification or weakening of the photoelectric current depending on the direction in which the battery current flows through the crystal. (Apr. 7, 1924.) 44 pp. Price 10 cents.

S487. A Quantitative Study of Regeneration by Inductive Feed Back. . *C. B. Jolliffe and Miss J. A. Rodman*

This paper shows by the use of simple alternating current theory that the amplification produced by inductive coupling between the tuned grid circuit and the plate circuit of an electron tube in an amplifying circuit network is produced by an apparent reduction in the resistance of the tuned circuit equal to $\frac{\mu M}{C_1 R_2}$. μ is the voltage amplification factor of the tube, M the mutual inductance of the coupling coils, R_2 the total resistance of the plate circuit, C_1 the capacity which is used to impress the voltage on the grid of the tube. The equations are completely confirmed by experiment for different values of impressed signal strength and different resistances in the tuned circuit. The amplification of the current was measured by measuring the increase in voltage across C_1 by means of an electron-tube voltmeter. The correction for reduction of resistance by capacitive feed back through the tube was determined by experiment. The equation is given for the current amplification in the tuned circuit obtained by regeneration. (Apr. 22, 1924.) 10 pp. Price, 10 cents.

S488. Thermal Expansion of Molybdenum . . . . . *P. Hidnert and W. B. Gero*

Expansion tests were made, for various temperature ranges between room temperature and 750° C., on molybdenum ingots prepared from fine and coarse grained molybdenum powders and on samples swaged to various diameters. The results are presented in figures and tables. The expansion curves generally show irregularities in the rates of expansion. Additional data on the effect of annealing on the expansion of swaged molybdenum are given, and several photomicrographs showing the structural changes that occurred are included. The average coefficients of expansion, 4.9×10^{-6} for the range 25 to 100° C. and 5.5×10^{-6} for the range 25 to 500° C. are given as the average values for commercial molybdenum. Variations in these values are to be expected due to variations in preparation or treatment. (May 5, 1924.) 16 pp. Price, 10 cents.

S489. Primary Radio-Frequency Standardization, by use of the Cathode-Ray Oscillograph..... .....*Grace Hazen and Frieda Kenyon*

This paper describes a method used to establish the primary radio-frequency standard of the Bureau of Standards. It uses a tuning fork with an electron-tube drive as the standard basis. The tuning-fork frequency of 1,000 cycles is compared with the frequency of a radio-frequency generating set by means of Lissajous figures produced in a cathode-ray oscillograph. The Lissajous figures are used to multiply ratios from 1½ to 22 times the basic frequency. The apparatus and procedure followed for the wave-meter standardization is given in detail.. (May 22, 1924.) 17 pp. Price, 10 cents.

S490. Spectra and Critical Potentials of Fifth Group Elements.....*Arthur E. Ruark, F. L. Mohler, Paul D. Foote, and R. L. Chenault*

Revised values of the critical potentials of As, Sb, and Bi are given. The resonance potentials of the neutral atoms correspond to the mean excitation voltages of groups of spectral lines. Photographs of the thermionic discharge in Bi were used to separate the excitation stages of the Bi atoms; groups of spark lines appear at 14 ± 1 and 25 ± 5 volts. The Bi absorption spectrum was studied. Classifications of lines of N^+, As, Sb, Bi, and Bi^+ were obtained. As, Sb, and Bi have doublet spectra. To describe phenomena connected with the existence of very narrow doublet levels in As^+ and Bi, it is proposed to introduce a new quantum number called the fine quantum number. (June 14, 1924.) 24 pp. Price, 10 cents.

S491. Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires.....*August Hund*

This paper furnishes the theoretical back ground for the method of frequency standardization employing short standing waves on parallel wires. The discussion shows that correct results can be obtained by the Bureau of Standards' method if the correction derived in the paper is employed in the calculation of the frequency. It is shown that the adjustment is based on a condition of resonance and, therefore, the settings are sharp and it is practical to approach in actual operation for frequency standardization the theoretical accuracy. The main part of the paper gives the practical deductions that may be drawn from the mathematical theory and also derives a correction to be used in calculating the frequency. The appendix gives the complete mathematical theory of the action of standing waves on parallel wires with special consideration of the system used at the Bureau of Standards. (June 23, 1924.) 54 pp. Price, 15 cents.

S492. Formulas, Tables, and Curves for Computing the Mutual Inductance of Two Coaxial Circles.... .....*Harvey L. Curtis and C. Matilda Sparks*

By a transformation of Maxwell's elliptic formula, series formulas are developed by which the mutual inductance of any two coaxial circles can be calculated. While these formulas are not new, they have been put in more convenient forms for computation. Tables and charts have been prepared which reduce the labor of computation, but do not give as high a degree of accuracy as can be obtained by the use of the formulas. However, the precision which can be obtained by the use of the tables is greater than that generally demanded in commercial practice. The tables and charts may also be used for the inverse problem, namely, the finding of the dimensions of two circles which will have a desired mutual inductance. (Aug. 5, 1924.) 36 pp. Price, 15 cents.

S493. Ultra-Violet Reflecting Power of Some Metals and Sulphides.....*W. W. Coblentz and C. W. Hughes*

The present paper gives data on the ultra-violet reflecting power of the sulphides of metals having a high metallic luster. The sulphides of lead, molybdenum, iron, and antimony were examined. In contrast with the metals, which have a low reflectivity in the ultra-violet and visible spectrum, followed by a high reflectivity in the infra-red, it is found that the sulphides of these metals have a high selective reflection in the ultra-violet and in the visible spectrum, followed by a lower and more uniform reflection in the infra-red. Data are given also on the reflecting power of graphite, duralumin, and magnalium. (Sept. 26, 1924.) 9 pp. Price, 5 cents.

S494. Aberrations of Long Focus Anastigmatic Photographic Objectives.....*A. H. Bennett*

The aberrations affecting the performance of a photographic objective are defined and their general effects on the definition of the image are discussed. A camera designed for the application of the Hartmann method of measuring spherical aberration, together with departure from the sine condition and also a precise lens bench method for the measurement of the other aberrations are described. Graphs are presented showing the aberrations of 33 photographic objectives of the anastigmatic type made by several different manufacturers. The variation in performance of the lenses investigated is discussed. (Oct. 16, 1924.) 54 pp. Price, 20 cents.

S495. A Radiometric Investigation of the Germicidal Action of Ultra-Violet Radiation.....
W. W. Coblentz and H. R. Fulton

In the present investigation an attempt is made to present the results of tests of germicidal action upon a quantitative radiometric basis. By means of screens, of mica and of glass, different portions of the ultra-violet spectrum are eliminated, and the effect upon the resulting bactericidal action noted. Data are given on (1) the energy distribution of the mercury arc, (2) the spectral transmission of the screens and of the culture media, (3) the effect of preexposure of the culture medium upon subsequent inoculation, (4) the effect of continuous and of intermittent exposure, (5) the spectral range of abiotic action, (6) the effect of the intensity of the radiation stimulus upon abiotic action, (7) the energy required to kill a bacterium, etc. (Dec. 10, 1924.) 40 pp. Price, 20 cents.

S496. Effect of Stress on the Magnetic Properties of Steel Wire.....*R. L. Sanford*

In the course of an investigation on nondestructive methods for testing steel hoisting rope, the effect of stress on the magnet properties has been studied. In the interpretation of the results Kennelly's law of magnetic reluctivity is used and a method of analysis has been developed for separating the material quantitatively into two components, one of which is in tension and the other of which is in compression. It is felt that this method furnishes a good basis for the utilization of the reluctivity law, not only in connection with the present problem, but also in other phases of magnetic analysis. (Dec. 16, 1924.) 15 pp. Price, 5 cents.

S497. Thermal Expansion of Aluminum and Various Important Aluminum Alloys.....*Peter Hidnert*

Data are given on the linear thermal expansion of (1) aluminum, (2) aluminum-copper alloys, (3) aluminum-silicon alloys, (4) aluminum-zinc alloys, (5) aluminum-manganese and aluminum-manganese-copper alloys, (6) aluminum-silicon-copper and aluminum-silicon-copper-manganese alloys, (7) Duralumin, and (8) Verilite. The preparation, chemical composition, heat treatment, etc., are included. Most of the 55 specimens investigated were examined from room temperature to about 500° C. Typical expansion curves of the various groups of samples are shown and discussed. The expansion of cast aluminum (99.95 per cent) from room temperature to 610° C. is represented by the equation, $L_t = L_o + (22.58\ t + 0.00989\ t^2)10^{-6}]$. (Jan. 9, 1925.) 35 pp. Price, 15 cents.

S498. Tables for the Calculation of the Mutual Inductance of Circuits with Circular Symmetry About a Common Axis.....*F. W. Grover*

The calculation of the inductance of a number of important common types of circuit depends upon formulas for the mutual inductance of coaxial circular filaments. For this latter case many formulas are available, but the computer is obliged to choose the proper formula for the case in hand, and the calculations are time consuming. In this paper are given tables which do away with the necessity for selecting the proper formula, and the computation is reduced to a simple multiplication. (Dec. 5, 1924.) 18 pp. Price, 10 cents.

S499. Investigations on the Platinum Metals—VII. Arc Spectra of the Platinum Metals (4500A to 9000A).....*W. F. Meggers*

Spectral data for the platinum metals have, heretofore, been entirely lacking for the longer waves of the visible and adjacent infra-red regions, and the earlier measurements appear to be incomplete or inaccurate even for the shorter wave portions. Materials of exceptionally high purity were used in this investigation, the purpose of which was to give a complete description of the longer wave portions of the standard arc spectra of the six metals of the platinum group. Results for wave lengths and intensities are given as follows: 1,260 lines for ruthenium (4498.16 to 8867.84A), 572 lines for rhodium (4503.80 to 8615.23A), 172 lines for palladium (4497.66 to 9234.02A), 942 lines for osmium (4500.74 to 8644.8A), 605 lines for iridium (4500.97 to 8426.11A), and 239 lines for platinum (4498.75 to 8762.48A). (Jan. 23, 1925.) 27 pp. Price, 10 cents.

S500. A Method of Determining the Dew Points of Fuel-Air Mixtures.....*Roy J. Kennedy*

A method is developed for determining the initial condensation temperatures of mixed vapors in a gas. The method is general and has been applied to hydrocarbon fuels in air. Measurements are made of three characteristics of the liquid solution in question, and of the molecular weight of the air or fuel gas involved, and the condensation temperature computed by means of an equation derived in the paper. (Feb. 17, 1925.) 17 pp. Price, 10 cents.

S501. Specific Heat of Superheated Ammonia Vapor.... .....*M. S. Osborne, H. F. Stimson, T. S. Sligh, Jr., and C. S. Cragoe*

This paper describes 108 measurements of the specific heat of superheated ammonia vapor at constant pressure within the temperature interval −15 to +150° C. and the pressure interval 0.5 to 20 atmospheres by a method of continuous flow combined with electric heating of the vapor. The flow calorimeter and its numerous accessories, which contain many important refinements, each having a direct bearing upon the accuracy of the measurements, are described and illustrated. Accessory data on the Joule-Thomson coefficient were obtained in order to evaluate the correction for pressure drop. The results of the specific-heat measurements are expressed within about 0.1 per cent by means of an empirical equation and a table of values at convenient intervals of temperature and pressure are appended. (Mar. 2, 1925.) 46 pp. Price, 15 cents.

S502. An Improved Type of Wave Meter Resonance Indicator.....*Morris S. Strock*

Most portable wave meters use, as a resonance indicator, a thermogalvanometer connected in the tuned circuit. This increases the resistance of the wave-meter circuit and gives comparatively small resonance deflections at low settings of the wave-meter condenser. As a result, the precision of setting the wave-meter condenser is reduced. This paper describes a resonance indicator for a portable wave meter which can be used in place of the thermogalvanometer. It gives an approximately uniform resonance deflection over the frequency range of the wave meter, does not appreciably increase its resistance, and is more sensitive than the thermogalvanometer. Experimental data are given to show that this method of resonance indication permits of precise settings of the wave-meter condenser. The resonance indicator may be added to most portable wave-meters and results in greater precision in their use. (Mar. 6, 1925.) 8 pp. Price, 5 cents.

S503. A Flow Calorimeter for Specific Heats of Gases *N. S. Osborne, H. F. Stimson, and T. S. Sligh, jr.*

The flow calorimeter described in this paper has been designed and built primarily for determining the specific heat of superheated ammonia vapor at constant pressure.

The aim has been to develop an instrument for accurate measurement of the specific heat of gases at pressures below 100 atmospheres and temperatures below 150° C. Refinements have been incorporated into the apparatus to make it sensitive, responsive, and to avoid thermal leakage, to control experimental conditions which affect steadiness, and to keep the size of the instrument within limits appropriate for small samples of pure materials.

The instrument has been used successfully to obtain data, in the superheat field of ammonia, which have been used in preparing tables of the thermodynamic properties of this refrigerating agent. (Apr. 4, 1925.) 33 pp. Price, 20 cents.

S504. A Method of Studying Electrode Potentials and Polarization.....*Homer D. Holler*

A resistance-coupled electron tube amplifier was used to operate an oscillograph for observing and recording the variations in potential of several electrodes without requiring any current from the electrode under investigation. By superposing alternating current upon the electrode it was possible with the use of a separately excited wattmeter to measure the potential due to resistance and compute the boundary resistance at the electrode. The paper is limited to a description of the method and illustrations of its use in the case of some typical electrodes, including both smooth and platinized platinum, carbon, lead, and copper in sulphuric acid, and copper in a copper sulphate solution. (Apr. 17, 1925.) 14 pp. Price, 15 cents.

S505. Critical Potentials Associated with Excitation of Alkali Spark Spectra.....*F. L. Mohler*

The experimental results include electrical measurements of critical potentials and a spectroscopic study of conditions for exciting alkali spark spectra. Data on all the alkali metals are given. It is found that the potential required to excite spark lines in the thermionic discharge depends on the current density, being from 8 to 12 volts higher for small currents than for large currents. The lower potential measures the work required to remove one electron from the rare gas shell of the atom while the higher value gives the work required to doubly ionize the atom by a single collision. (Apr. 16, 1925.) 25 pp. Price, 10 cents.

S506. Theory and Interpretation of Experiments on the Transmission of Sound Through Partition Walls . . . . . *Edgar Buckingham*

As a preliminary, the principles brought out by W. C. Sabine's work on the reverberation of closed rooms are discussed, and the equations needed for interpreting the observed facts are deduced for further reference. The theory of reverberation suggests experimental methods for measuring the acoustic transmittance of panels by means of observations in two closed rooms which are in acoustic communication only through the panel, which is set up as a part of the partition wall between the rooms. The necessary equations are developed for interpreting such experiments and expressing the results in absolute units, so as to give values which are characteristic of the panel alone and independent of the peculiarities of the laboratory where the tests are conducted. The proposed methods are then compared with those employed by Paul E. Sabine and F. R. Watson and it is shown that the quantities measured by the different methods are not physically identical, hence discrepancies are to be expected among the values obtained, although it seems probable that all the methods would arrange any given set of panels in the same order. (May 26, 1925.) 27 pp. Price, 10 cents.

S507. A New Interference Apparatus for Testing Haemacytometers . . . . . *C. G. Peters and B. L. Page*

Haemacytometers or counting chambers, used in determining the number of corpuscles in the blood, were previously tested with a micrometric instrument, which was subject to imperfections that produced appreciable errors in the measurements. A new instrument, based on the principle of the interference of light waves, which is free from instrumental errors and with which a chamber can be measured in one minute with an uncertainty of not more than 0.1 micron was, therefore, designed and constructed. A description of the new apparatus and the results of comparative tests of the accuracy and reliability of both instruments are presented in this paper. (June 3, 1925.) 16 pp. Price, 10 cents.

S508. Spark Photography and Its Application to Some Problems in Ballistics . . . . . *Philip P. Quayle*

Apparatus for securing shadowgraph pictures by spark illumination of extremely short duration is described. The application to the study of projectiles in flight both near to and remote from the firing piece is discussed and numerous photographs are presented giving evidence as to the acceleration of a projectile outside the piece and on other physical phenomena. The object of the photographs is to illustrate the effectiveness of the method rather than to present an exhaustive study of the subjects to which they relate. (June 13, 1925.) 40 pp. Price, 20 cents.

TECHNOLOGIC PAPERS

[For publications in following list that are out of print or procurable only from Superintendent of Documents, Government Printing Office, Washington, D. C., see the supplement to this Circular.]

T1. Effect of Preliminary Heat Treatment upon the Drying of Clays . . . . . *A. V. Bleininger*

Investigation undertaken to ascertain the possibility of using excessively plastic clays which on drying show losses due to cracking and checking, by subjecting the clays in the crude state to a preliminary heat treatment before working them by the usual methods.

Preheating offers a possible commercial method for the treatment of excessively plastic clays which can not be worked and dried successively by other means, subject to certain limitations. Methods and conditions are discussed. (Dec. 6, 1910.) 53 pp. Price, 10 cents.

T2. The Strength of Reinforced Concrete Beams—Results of Tests of 333 Beams (First Series) . . . . . *Richard L. Humphrey and Louis H. Losse*

Nature of Tests.—These tests form a part of the study of the behavior of reinforced concrete beams under load. This series consisted of tests of gravel, granite, limestone, and cinder concrete, with seven percentages of reinforcement varying from 0.5 to 2 per cent. Beams were accompanied by cylindrical and cubical test pieces for determining compressive strength, initial modulus of elasticity, yield point, bond, etc.

Methods.—The beams were 8 by 11 inches in section and 13 feet long, tested on 12-foot centers by applying loads at the third points. Observations were made of deformation of upper and lower fibers, deflection of beam at the center, slip of the reinforcement, and development of cracks as the loads were applied.

Results.—Complete data are given of the beam tests, results are summarized and illustrated by typical curves, diagrams, and photographs, and studies are made of the values usually used in the design of a beam. (June 27, 1911.) 200 pp. Price, 50 cents.

T3. Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concretes, Together with Tests of Damp-proofing and Waterproofing Compounds and Materials . . . . . *Rudolph J. Wig and P. H. Bates*

Nature of Tests.—Results of tests of the absorption of water and permeability to water of Portland cement mortars and concretes, together with tests of 40 commercial so-called "damp-proofing" and "waterproofing" compounds.

Methods.—Tests were made by exposing one surface of small slabs to water, both permitting absorption by capillarity and subjecting one surface to hydrostatic pressure, measuring the quantity of water passing through.

Results.—None of the integral compounds was found to be of much value as damp-proofing or waterproofing mediums nor in reducing the absorption. Well-made Portland cement mortar and concrete were found to be impermeable to the passage of a sensible quantity of water under hydrostatic pressures of 20 pounds per square inch, and rich mortars if aged sufficiently will be impermeable to 60 and 80 pounds per square inch hydrostatic pressure. (Aug. 22, 1911.) 127 pp. Price, 20 cents.

T4. The Effect of Added Fatty and Other Oils Upon the Carbonization of Mineral Lubricating Oils. . . . . *C. E. Waters*

Continuation of work published in Bul. 7, p. 365 (1911). Known mixtures of mineral oil with fatty oils, etc., subjected to the carbonization test. The amount of insoluble precipitate is variously affected. Rosin, asphalt, etc., caused an increase; rosin oil, lard oil, rapeseed oil, and tallow caused a decrease. Oil exposed to the oxidizing action of sunlight and air, and oil mixed with ferric oxide yielded more of the carbonized product.

The addition of fatty oils is not yet recommended. More work is to be done with a view to determine the corrosive action on metals. (Aug. 24, 1911.) 14 pp. Price, 5 cents.

T5. The Effect of High-Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete . . . . . *Rudolph J. Wig*

Nature of Tests.—Results of tests made to determine the accelerating action of steam on the hardening of Portland cement mortar and concrete. Tests were made varying the steam pressure, duration of exposure, age and consistency of mixtures, etc.

Method.—Cylindrical test pieces 8 inches in diameter by 16 inches in length were exposed in a steel tank equipped with removable head, steel cars, and track, and provided with regulating valves for controlling steam pressure. The ultimate compressive strength, initial modulus of elasticity, and yield point were then determined.

Results.—Steam under pressure greatly accelerated the hardening of the mortar and concrete. Under certain conditions, a compressive strength was obtained greatly in excess of that obtained by aging normally for one year. (Sept. 5, 1911.) 25 pp. Price, 10 cents.

T6. The Determination of Chromium and Its Separation From Vanadium, In Steels . . . . . *J. R. Cain*

Sources of error in certain methods used for this determination, which limit their accuracy, are described. A procedure is given for the quantitative precipitation of chromium (and of vanadium) from solutions of steels (permitting a separation from most of the iron), for its separation from this precipitate in pure condition and for its determination. (Nov. 1, 1911.) 6 pp. Price, 5 cents.

T7. The Testing of Clay Refractories, With Special Reference to Their Load Carrying Ability at Furnace Temperatures . . . . . *A. V. Bleininger and G. H. Brown*

Nature of Tests.—General consideration of the refractoriness of fireclay bricks, their viscosity at furnace temperatures, nature and manufacture of refractory clays, effect of accessory constituents upon softening temperatures, effect of fluxes upon refractoriness, effect of heat upon dehydration, contraction, crystallization, and load carrying capacities.

Results.—General conclusions are stated and specifications proposed for No. 1 and No. 2 refractories. (Dec. 15, 1911.) 78 pp. Price, 15 cents.

T8. A Rapid Method for the Determination of Vanadium in Steels, Ores, etc., Based on Its Quantitative Inclusion by the Phosphomolybdate Precipitate . . . . . *J. R. Cain and J. C. Hostetter*

Vanadic acid may be precipitated quantitatively by ammonium phosphomolybdate. The vanadium may be separated from the precipitate, or it can be accurately determined in it by reduction and titration with permanganate. (Oct. 26, 1911.) 20 pp. Price, 5 cents.

T9. The Density and Thermal Expansion of Linseed Oil and Turpentine . . . . . *H. W. Bearce*

The paper describes an experimental determination of the density and thermal expansion of linseed oil and turpentine. The work was undertaken for the purpose of obtaining the necessary data for preparing tables to give the density of these substances at any temperature between 10° and 40° C. from the density at any other temperature. The data obtained are herein presented, together with the tables prepared therefrom. There are included also tables for converting pounds to gallons and gallons to pounds. (Apr. 15, 1912.) 27 pp. Price, 10 cents.

T10. The Melting Points of Fire Brick . . . . . *C. W. Kanolt*

Determinations have been made of the melting points of 62 samples of fire brick and of material of importance in the manufacture of fire brick. These samples included fire-clay brick, bauxite brick, silica brick, magnesia brick, chromite brick, kaolin, pure alumina, pure silica, bauxite, bauxite clay, and chromite. The materials were heated in an electric vacuum furnace. Temperatures were measured with an optical pyrometer. An improved method of calibrating optical pyrometers is described. (June 15, 1912.) 17 pp. Price, 5 cents.

T11. Comparison of Five Methods Used to Measure Hardness . . . . . *Ralph P. Devries*

The static tests of hardness studied are the cone and Brinell sphere. The dynamic tests are the Shore Scleroscope and Ballantine. The Bauer drill test for measuring the workability of metals is also included. The tests were made on a series of metals which ranged from very hard steels to comparatively soft alloys. The laws governing the resistance to indentation are experimentally deduced for spheres of different sizes and cones of different degrees of angular opening. The effect of elastic deformation of the sphere upon the results of sphere tests is determined by means of a method which involves the exact measurement of the depth of indentation. This method of measurement is also applied to the cone tests. The study of the individual methods shows (1) the possibility of obtaining rational hardness numerals for the cone and sphere tests, and (2) that the dynamic tests for hardness do not agree in general with the results of static tests. (July 22, 1912.) 27 pp. Price, 5 cents.

T12. Action of the Salts in Alkali Water and Sea Water On Cements . . . . . *P. H. Bates, A. J. Phillips, and Rudolph J. Wig*

Nature of Tests.—A series of laboratory and field investigations made to determine the suitability and permanency of various cements in structures exposed to the chemical and mechanical action of the salts present in sea water and alkali water.

Methods.—The laboratory investigation consisted in subjecting various typical cements to salt solutions for a period of months and their action noted by analyzing the solutions as removed and the residue at the end of the test. Small hollow cylinders of cement and cement mortar were made and exposed to the percolation of various salt solutions. Field investigations were made by exposing cements in the form of briquets and concrete test pieces to sea water at a branch laboratory established at Atlantic City, N. J.

Results.—Tentative conclusions are drawn showing that concrete is subject to disintegration by the mechanical force exerted by the crystallization of salt in its pores if sufficient quantity is permitted to accumulate; that there is no relation between the chemical composition of a cement and the rapidity with which it reacts with sea water when brought into intimate contact; and that marine construction appears to be a problem of method rather than materials, as concrete sets and permanently hardens as satisfactorily in sea water as in fresh water or in the atmosphere, if it can be placed in the forms without undue exposure to the sea water while being deposited. (Nov. 1, 1912.) 157 pp. Price, 25 cents.

T13. The Evaporation Test for Mineral Lubricating and Transformer Oils.....*C. E. Waters*

Concordant duplicate results can not be obtained unless oils are heated in vessels of the same size. The loss in weight on heating a given oil depends, other things being equal, on the area of surface exposed and to a less extent on the depth of the tube in which the oil is heated, and still less (for the first few hours) on the amount of oil taken. Gill's method (heating the oil absorbed in filter paper) was tried and gave very discordant results. (Jan. 1, 1913.) 13 pp. Price, 5 cents.

T14. Legal Specifications for Illuminating Gas.....
.....*E. B. Rosa and R. S. McBride*

A paper written for the seventh annual meeting of the American Gas Institute discussing changes under consideration for C32 of the Bureau. The relative merits of gross, net, and total heating values of gas for standards of specification, the standard candlepower test burner, and the "standard conditions," so called, for gas measurement are discussed from the standpoint of technical gas specifications. [See C32.] (Jan. 10, 1913.) 31 pp. Price, 10 cents.

T15. Surface Insulation of Pipes as a Means of Preventing Electrolysis.....*Burton McCollum and O. S. Peters*

This paper describes a series of tests intended to determine whether or not it is practicable to protect underground metallic structures from corrosion by stray electric currents by means of insulating coatings of paints, dips, wrappings, etc. A number of letters from water and gas companies are also included as illustrating what has been the practical experience with these coatings in the field. The general conclusion arrived at is that the protection to be derived from the use of these coatings is only temporary. (Jan. 5, 1914.) 44 pp. Price, 15 cents.

T16. The Manufacture of Lime.....*W. E. Emley*

An account of the methods of lime manufacture at various plants, including a description of the plants. (Jan. 1, 1913.) 130 pp. Price, 25 cents.

T17. The Function of Time in the Vitrification of Clays..
.....*G. H. Brown and G. A. Murray*

Time is an exceedingly important factor in the maturing of clays and bodies. A certain result may be obtained either by the use of a higher temperature for a shorter time or a lower temperature for a longer time. This fact we see constantly illustrated in the firing of all kinds of clay products, the melting of glass, the softening of pyrometric cones, etc. Yet there are definite thermal limits to which such relations are confined. These correspond to the lowest temperature at which partial softening, which is a necessary condition of vitrification, can take place. The plan the present work followed was that of Bleininger and Boys, consisting in heating clays to their maturing temperatures at definite rates and comparing the heat effect by means of porosity and shrinkage determinations. Six clays were studied in this connection. (May 20, 1913.) 26 pp. Price, 5 cents.

T18. Electrolysis in Concrete.....
.....*E. B. Rosa, Burton McCollum, and O. S. Peters*

Description of experimental researches on the effects of electric currents on concrete. The investigation has consisted of three parts: (*a*) Laboratory investigations relating to the nature and cause of the phenomena produced by the passage of electric currents through concrete; (*b*) investigations in the field with the view of establishing the probable extent of the danger in practice and the circumstances under which trouble is most likely to occur; (*c*) a study of the various possible means of mitigating trouble from this source leading to specific recommendations. (Mar. 19, 1913.) 137 pp. Price, 35 cents.

T19. Physical Testing of Cotton Yarns . . . . . *W. S. Lewis*

PURPOSE.—Investigation of the desirability of improving the technical regulations of the trade, of developing cotton-yarn specifications, to improve methods of testing, and to determine some of the physical properties of cotton yarns.

NATURE OF TESTS.—General consideration of single and two-ply yarns relative to their size, twist, and tensile strength within cops, bobbins, skeins, respectively, etc., and also their behavior under various relative atmospheric humidities.

RESULTS.—Coarse yarns are not more difficult to spin to the required size than fine yarns. "Singles" yarns are spun with greater uniformity in size than "two-ply" yarns. Under usual atmospheric changes the size of a cotton yarn can be increased as much as five counts, or over 6 per cent, and the yardage to the extent of 3,500 yards per pound with No. 80 "singles" and 2,000 yards per pound with No. 100 two-ply yarns. Tensile strength is best determined upon single strands rather than by the "lea" method. The strength of "singles" yarns can be increased 18 per cent and "two-ply" yarns 16 per cent by increasing the relative atmospheric humidity from 45 to 85 per cent. The yarn number or count can be determined upon 30-yard specimens with an accuracy much greater than it can be manufactured. (Apr. 1, 1913.) 31 pp. Price, 10 cents.

T20. Determination of Sulphur in Illuminating Gas . . . . . *R. S. McBride and E. R. Weaver*

Six common forms of apparatus or modifications of these were tested; the results show that the amount of sulphur in a gas can be determined with sufficient accuracy for official or commercial testing with any of the apparatus used. For general use the Referees, the Hinman-Jenkins, or perhaps the new model Elliott will be most satisfactory. Directions as to form and methods of operation of these are given. For the determination of the sulphate in the solutions obtained from the apparatus, two gravimetric, one volumetric, and one turbidimetric procedures were used; all of these were satisfactory, but some better adapted for certain circumstances than the others. (Mar. 7, 1913). 46 pp. Price, 10 cents.

T21. The Dehydration of Clays . . . . . *G. H. Brown and E. T. Montgomery*

The paper gives a review and a statement of results of experimental work upon the dehydration of clays. The combined water appears to behave as if in solid solution, and can not be said to have a definite dehydration temperature. Dehydration begins at 450° C, becomes very rapid at 500°, but not complete until 800° is reached. Contrary to usual idea, it is shown that the clay substance of impure clays represents a type essentially different from that of the purer materials. Dehydration need not destroy plasticity, hence the combined water appears not to directly affect the phenomenon of plasticity. Organic compounds can not be primary cause of plasticity, since these are oxidized in pure air at 500°. Finally, drying shrinkage was shown not to be a true criterion of plasticity. (Apr. 25, 1913.) 23 pp. Price, 5 cents.

T22. The Effect of Overfiring Upon the Structure of Clays . . . . . *A. V. Bleininger and E. T. Montgomery*

Many clays develop a vesicular structure either just before vitrification sets in or during vitrification, or immediately after complete contraction has been reached. Owing to the injurious effect of this development, it seems important to trace its extent for different types of clays. This is especially important where products like paving brick, sewer pipe, glass pots or similar dense articles are concerned. It is likewise of considerable interest to determine whether upon vitrification equilibrium is approached. It has been found that the determination of the vesicular pore space is of considerable importance, although its determination has been neglected hitherto. It shows clearly why it is unsafe to use certain clays for exacting conditions. At the same time it has been proved that clays even after vitrification are far from having reached molecular equilibrium which is shown by the constant slope of the true specific gravity curve. (Apr. 6, 1913.) 23 pp. Price, 5 cents.

T23. The Technical Control of the Colloidal Matter of Clays . . . . . *H. E. Ashley*

In its briefest terms the argument of this paper is (1) that the plasticity of a clay is directly conditioned by the character and amount of the colloid matter in the clay; (2) consequently by measuring and controlling the colloid matter present it should be possible to control the plasticity of the clay and to obtain the great advantages incident to such control. The first of these statements, though generally accepted, is supported by additional evidence in this paper, but the main aim is to justify the second statement. The argument is preceded by a short sketch of the present status of the chemistry of colloids, in so far as it pertains to the subject in hand, and by necessary definitions and brief discussions of certain physico-chemical concepts. Then follows a general discussion supported by experimental work on clays, concluding with some applications of the work to specific problems. (Dec. 18, 1912.) 118 pp. Price, 15 cents.

T24. The Determination of Phosphorus in Steels Containing Vanadium . . . . . *J. R. Cain and F. H. Tucker*

As a preliminary to the determination of phosphorus as phosphomolybdate in steels containing vanadium, the proper conditions for reducing the vanadium to the tetravalent state by ferrous sulphate are described, together with the other conditions to be observed in this determination. (May 17, 1913.) 11 pp. Price, 5 cents.

T25. Electrolytic Corrosion of Iron in Soils . . . . . *Burton McCollum and K. H. Logan*

The paper deals with the fundamental laws of electrolytic corrosion in soils and presents data showing the effects of the various factors which may influence electrolytic corrosion, such as current density, moisture content of soil, temperature, depth of burial, oxygen supply, chemical constituents of the soil, different kinds of iron, and effect of very low voltage. The relation of earth resistance to electrolysis is discussed very briefly and the laws of variation of earth resistance with moisture, temperature, and pressure are discussed. A list of conclusions is presented giving a brief summary of the results of the investigations. (June 12, 1913.) 69 pp. Price, 15 cents.

T26. Earth Resistance and its Relation to Electrolysis of Underground Structures . . . . . *Burton McCollum and K. H. Logan*

This paper presents some of the results of laboratory and field work of the Bureau of Standards in connection with the study of electrolysis. Three methods of measuring the specific resistance of soil are described, two of which do not require the removal of the soil from its original position.

Results of a large number of measurements show the resistivity of soil to vary in most cases between 1000 and 5000 ohm-centimeters.

The effects of the principal factors which influence soil resistance, i. e., pressure, moisture, temperature, and polarization, are described and the relation of each to electrolysis is discussed. (Dec. 20, 1915.) 48 pp. Price, 15 cents.

T27. Special Studies in Electrolysis Mitigation. I. A Preliminary Study of Conditions in Springfield, Ohio, with Recommendations for Mitigation and Control . . *E. B. Rosa and Burton McCollum*

This paper is divided into two main parts. After a brief discussion of railway and electrolysis conditions in Springfield, Ohio, Part I takes up in detail the different methods of electrolysis mitigation with the general conclusion that the potential gradients should be reduced by a system of insulated return feeders. Part II discusses the application of the insulated return-feeder system to the railways of Springfield, points out various ways of improving the rail return, and offers a complete redesign of the negative feeder system, with the conclusion that the changes shown will give practical immunity from electrolysis. [Superseded by T54.] (June 19, 1913.) 55 pp. Price, 15 cents.

T28. Methods of Making Electrolysis Surveys.....
.....*Burton McCollum and G. H. Ahlborn*

This paper deals with the methods of procedure to be followed in examining underground pipes and cables and the return systems of electric railways, in order to determine the liability of the pipes and cables to damage from stray electric currents from the railways.

The various classes of electrical measurements are described and methods of procedure are outlined in some detail. The selection of instruments for making such tests is treated, and some of the more important considerations involved in the interpretation of the results of electrolysis surveys are discussed. (Aug. 26, 1916.) 84 pp. Price, 20 cents.

T29. Variation in Results of Sieving with Standard Cement Sieves.....*R. J. Wig and J. C. Pearson*

PURPOSE OF TESTS.—This investigation was undertaken to determine the possible variations obtainable in determining the fineness of cements by using standard cement sieves, and to determine the tolerance which should be allowed for the "personal equation" and differences in the sieves.

METHODS.—The tests were made on 68 different sieves by different operators, an attempt being made to determine the variation due to differences in the methods of sieving by the same operator and by different operators.

RESULTS.—A tolerance of 1 per cent from the specification should be allowed with a No. 200 sieve and 0.5 per cent from the specification with the No. 100 sieve, when every care is taken to conduct the test in strict accordance with standard methods. (Aug. 1, 1913.) 16 pp. Price, 5 cents.

T30. Viscosity of Porcelain Bodies.....
.....*A. V. Bleininger and Paul Teetor*

In the vitrification of ceramic bodies there is assumed to be a considerable superficial force tending to contract the mass, and lowered viscosity or softening which will permit the rearrangement of the molecules. Owing to the fact that no numerical values are available with reference to the degree of softening of ceramic bodies, it was thought desirable to carry on experiments with the purpose of determining the degree of viscosity reached by a series of bodies of the porcelain type. As a measure of the viscosity, the deformation under tensile strain was used. The results are tabulated and given in the form of curves. This method of studying ceramic bodies is capable of producting valuable results and might, with advantage, be applied to clays and other mixtures. (Nov. 20, 1913.) 11 pp. Price, 5 cents.

T31. Some Leadless Boro-Silicate Glazes Maturing at about 1100° C.....*E. T. Montgomery*

In this work the most promising glaze compositions, deduced from the work of Seger, Stull, Mellor, and others, have been applied to a standard American pottery body of the vitreous type. In addition, the calcium oxide was in part replaced by magnesium, barium and strontium oxide. The glazes were examined for their dipping quality, fusion range, brilliancy, hardness, crazing, and their effect upon underglaze colors. The results of Seger have been confirmed. Some good leadless glazes were produced. Compared with the plumbiferous glaze they lack somewhat in brilliancy and show a much shorter fusion range. Their effect upon some of the underglaze colors is deleterious. Other colors, however, are developed very satisfactorily. The kiln losses because of the use of leadless glazes would undoubtedly be higher than with the present glazes. (Dec. 15, 1913.) 22 pp. Price, 5 cents.

T32. Electrolysis from Electric Railway Currents and Its Prevention: Experimental Test on a System of Insulated Negative Feeders in St. Louis.....
.....*E. B. Rosa, Burton McCollum, and K. H. Logan*

This paper gives the details of the cost and design of an installation of insulated negative feeders with resistance taps which was constructed for the purpose of mitigating troubles due to stray currents from the electric

railways in the territory supplied by one of the substations of St. Louis. A comprehensive electrolysis survey of the city was made both before and after the installation of the negative feeders, and the details of this survey are given and discussed. A comparison of the costs of insulated and uninsulated negative feeder systems is also given. (Dec. 27, 1913.) 34 pp. Price, 10 cents.

T33. Determination of Carbon in Steel and Iron by the Barium Carbonate Titration Method . . . . . *J. R. Cain*

There are described sources of difficulty and error in carrying out the barium carbonate titration method, with means for obviating these. (Jan. 31, 1913.) 12 pp. Price, 5 cents.

T34. Determination of Ammonia in Illuminating Gas . . . . . *J. D. Edwards*

Four common forms of apparatus and a new form designed on the principle of the Cumming wash bottle were tested; the results show that the amount of ammonia in a gas can be determined with sufficient accuracy for official or commercial testing with any of the five forms. Tests were made on different indicators and their suitability for this determination pointed out. The choice of indicator was found to be of more importance than the form of apparatus chosen. (Mar. 2, 1914.) 23 pp. Price, 10 cents.

T35. Combustion Method for the Direct Determination of Rubber . . . . . *L. G. Wesson*

The method consists in forming an insoluble nitrosite of rubber by the action of nitrogen trioxide gas upon a finely ground, acetone-extracted sample of the rubber suspended in chloroform. The nitrosite is filtered out, dissolved in acetone, and an aliquot portion of the acetone extract is concentrated and then distributed over alundum in a porcelain boat, using ethyl acetate to complete the transfer. After expulsion of all acetone and ethyl acetate, the residue is burned in a combustion apparatus and the resultant carbon dioxide absorbed and weighed. From the carbon found the rubber is calculated upon the assumption that the nitrosite burned contains all the carbon of the rubber. Details of the combustion apparatus and operation are given. Results on samples of known composition show the method to be fairly accurate for raw rubber and high-grade vulcanized products. (Feb. 13, 1914.) 11 pp. Price, 5 cents.

T36. Industrial Gas Calorimetry . . *C. W. Waidner and E. F. Mueller*

An investigation of some of the methods of calorimetry available for the industrial measurement of the heating values of gases, the sources of error to which such measurements are liable, the important precautions necessary, and the accuracy attainable in these measurements. Eight calorimeters of the flow type and one of the comparison type were included in the investigation. (Mar. 1, 1914.) 150 pp. Price, 40 cents.

T37. Iodine Number of Linseed and Petroleum Oils . . . . . *W. H. Smith and J. B. Tuttle*

The iodine values of raw, boiled, and burnt linseed oils, and petroleum oils, were determined by the Hanus method, varying widely the amounts of oil and iodine used and the time of absorption. A study of the effect of temperature on the iodine value was made. It is shown that in order to obtain concordant results a prescribed procedure must be followed and exact conditions stated. (Apr. 28, 1914.) 17 pp. Price, 10 cents.

T38. Observations on Finishing Temperatures and Properties of Rails . . . . . *G. K. Burgess, J. J. Crowe, H. S. Rawdon, and R. G. Waltenberg*

Measurements were made in four rail mills of ingot and finishing temperatures. The former range from 1075° to 1150° C, and the latter from 880° to 1050° C, but are usually within 50° of 935°. The temperature of every rail can readily be measured and methods of temperature measurement for rolling mills are discussed. The mechanical properties, chemical

analyses, and microstructure were determined as well as melting range (1470° to 1525°), critical region on heating (732° ±7) and on cooling (650° to 680°), and temperature distribution in cooling of a 100-pound section from 1070°. Measurements of expansion showed Bessemer rails have a coefficient (0 to 1000°) of 0.0_4 146 and O. H. of 0.0_4 156. The "shrinkage clause" is discussed, and it is shown that it (A. S. T. M.) permits finishing rails at 1120° C. (Apr. 28, 1914.) 63 pp. Price, 35 cents.

T39. Analysis of Printing Inks..... *J. B. Tuttle and W. H. Smith*

A procedure of analysis of some of the common printing inks is given. This is the result of the experience of the Bureau during five years. It is claimed that the procedure is sufficiently accurate to determine the approximate composition of the ink. (June 12, 1914.) 20 pp. Price, 10 cents.

T40. The Veritas Firing Rings..*A. V. Bleininger and G. H. Brown*

The veritas firing rings are an adaptation of the Wedgwood pyrometer and consist of unburned clay rings of uniform composition and size. These are placed in different parts of ceramic kilns and are withdrawn during various stages of the firing. By determining the shrinkage of the pieces, using a simple calipering instrument, the progress of the heat effect due to increase in temperature is observed. The arbitrary shrinkage numbers of the device, as well as the actual shrinkages of the discs, were correlated with the temperatures and determined by means of thermocouples, both for rapid and slow firing. The shrinkage curves of the rings were found to be quite regular and hence these are suitable for the work for which they are intended. A new series of rings designed to be used for lower temperatures was found to behave irregularly. (June 5, 1914.) 10 pp. Price, 5 cents.

T41. Lead Acetate Test for Hydrogen Sulphide in Gas..
.....*R. S. McBride and J. D. Edwards*

The effects of numerous variations in the procedure and apparatus used in the detection of hydrogen sulphide in gas by the lead acetate test have been investigated; the results obtained show both the absolute and the relative sensitivity of the various methods which may be used in official or works laboratories. A method is recommended for use which is quick and convenient and gives reproducible results; a simple and inexpensive form of apparatus is described. The quantitative as well as the commercial significance of the results is pointed out. (Aug. 19, 1914.) 46 pp. Price, 25 cents.

T42. Standardization of No. 200 Cement Sieves.....
.....*R. J. Wig and J. C. Pearson*

An investigation was made of the magnitude and cause of variation in results obtained with standard sieves, and to devise means of improving the accuracy of fineness determinations. While the Bureau specifications for standard sieves had caused an improvement in their quality, a wide discrepancy still exists in sieving values. Cooperative sieving tests were made in 80 outside laboratories and at the Bureau, 162 standard sieves being tested. Studies were made of methods of standardizing sieves, of sieve variables, and the variables of manipulation. The suitability of materials suggested for use as standard samples for checking sieves was also studied.

RESULTS.—(1) No. 200 sieves as now standardized may vary 5 per cent or more in sieving value; (2) there is carelessness in making the fineness determination in many laboratories; (3) sieve cloth is subject to improvement (4) a correction factor can be applied to make determinations reproducible to within 0.5 per cent of a fundamental standard. The Bureau of Standards will maintain fundamental standard sieves and issue a standard sample of cement at a nominal price for checking sieves. A revision has been made in the specification for standard No. 200 sieves. (July 30, 1914.) 51 pp. Price, 10 cents.

T43. Hydration of Portland Cement . . . . . .
. . . . . *A. A. Klein and A. J. Phillips*

The Geophysical Laboratory established the constitution of the compounds present in Portland cement clinker. It was thought advisable to study the effects of various amounts of water and steam at atmospheric and high pressures on the individual cement compounds and on Portland cement itself. The work included preparation of the compounds, their hydration on microscope slides with excess of water, their hydration in a cylinder with steam at various temperatures and pressures, the molding of the specimens with water in normal consistencies, and the study of the products so formed with the petrographic microscope to determine the changes. The results indicate how the hydration of cements is brought about and show the reactions and crystallographic changes. (Apr. 18, 1914.) 71 pp. Price, 20 cents.

T44. Investigation of the Durability of Cement Drain Tile in Alkali Soils . . . . . .
R. J. Wig and G. M. Williams (with S. H. McCrory, E. C. Bebb, and L. R. Ferguson)

Laboratory investigations show that cement concrete is subject to disintegration by alkali salts. Practical experience indicates that some concretes are less susceptible to such action than others and are quite permanent even if exposed in very concentrated alkali soils. Several millions of dollars are being spent annually in the drainage of alkali soils in the west, so that its economic importance makes it advisable to observe on cement drain tile of known composition exposed under normal service conditions in operating drains in concentrated alkali soils.

About 9000 drain tile (16 different types), a sufficient number to extend the investigation over a period of more than 10 years, were shipped to projects where concentrated alkali was found, in Wyoming, Montana, Utah, Washington, Arizona, New Mexico, and Colorado, and to fresh-water projects in Missouri and Minnesota.

Results.—The first year's tests were made in 1914, the tile being crushed at the site in a portable tile-testing machine. With few exceptions the tile were found to be in good condition. A few failures or weakened tile were found among the leaner mixtures at several projects, while at others where the alkali appeared to be concentrated no failures were discovered.

The results indicate that special care should be observed to employ only the best materials and workmanship and relatively rich mixtures in the manufacture of tile to be exposed in concentrated alkali soils. No further conclusions can be drawn until additional results are available. (July 22, 1915.) 56 pp. [Superseded by T95.]

T45. A Study of Some Recent Methods for the Determination of Total Sulphur in Rubber . . . . . .
. . . . . *J. B. Tuttle and A. Isaacs*

The results show that the Waters and Tuttle method, now in use at this Bureau, is the most satisfactory and entirely reliable. A new procedure is suggested for the determination of total sulphur in rubber which will be of particular value in the analysis of rubber compounds containing high percentages of free sulphur. (May 5, 1915.) 16 pp. Price, 5 cents.

T46. A Study of the Atterberg Plasticity Method . . . . . .
. . . . . *Charles S. Kinnison*

Atterberg evaluates the plasticity of a clay in accordance with the range of water content within which it can be considered plastic. The plasticity value is expressed by a number obtained by subtracting the water content of the clay at the lower plasticity limit from the water content at the upper limit. The work of this investigator on Swedish clays is described and the results critically reviewed. The method was tried on 20 American clays and the results compared with evaluations based on per cent water of plasticity, per cent shrinkage, and per cent water absorbed by the clay powders while in an atmosphere of high humidity. It was brought out that the Atterberg method does not give results which check

observations made from actual experience with the clays, principally because it does not account for a sufficient number of factors. A revised adaptation of the Atterberg method is suggested in which the plasticity number is coordinated with the amount of water required to develop the best working properties of the clays. This scheme grouped the clays satisfactorily into those varieties which are sticky and would give trouble in working in a stiff-clay machine, and those which are nonsticky and admit of ready working. (May 25, 1915.) 18 pp. Price, 5 cents.

T47. Value of the High-Pressure Steam Test of Portland Cement.....*Rudolph J. Wig and Herbert A. Davis*

This report contains the results of tests made to ascertain the value of the high-pressure steam test as a means of determining the soundness and cementing quality of Portland cement. The physical properties, such as tensile and compressive strength of mortars, compressive strength of concrete, linear change of neat cement prisms when stored in air or water, or treated in high-pressure steam, were determined on cements that passed the proposed high-pressure steam test and cements which failed to meet the requirements of this test. The results of the investigation show that a high-pressure steam test should be used where cement or cement products are to be treated or "cured" in steam under pressure, and is of value in indicating the possible action of neat cement when stored in dry air. However, there is nothing to indicate that cement passing this test is superior in cementing quality when used in concrete. Furthermore for work under practical conditions of construction the high-pressure steam test is of no value as indicating the ultimate soundness of concrete. (Aug. 18, 1015.) 34 pp. Price, 15 cents.

T48. An Air Analyzer for Determining the Fineness of Cement.....*J. C. Pearson and W. H. Sligh*

A study of various types of elutriators has led to the development of an air analyzer for mechanically analyzing that portion of cement passing a No. 200 sieve. An apparatus of this kind has been greatly needed to aid in determining the value of fineness in cements, an investigation which is now in progress.

Special attention has been given to the mechanical features of the analyzer, not only to insure pure and complete separations of fine material, but also to make possible the calibration of the apparatus in absolute terms. The calibration consists in determining with the microscope the "sizes of separation"; that is, the average limiting diameters of the particles in the several fractions. For most purposes the nominal sizes of separation are sufficiently close to apply to all normal Portland cements, but special calibrations can be readily made in cases requiring the maximum attainable accuracy.

Several methods of measuring the sizes of particles have been studied, and a simple system of measurement has been tentatively adopted as a basis for plotting the fineness curves. These curves are analogous to the mechanical analysis curves of sands and other aggregates, and show the granulometric composition of cements in terms of size of particles and percentage of total. This method of standardizing the analyzer greatly increases its usefulness and adapts it to the study of many finely divided materials. (Sept. 8, 1915.) 74 pp. Price, 20 cents.

T49. Emergent-Stem Correction for Thermometers in Creosote-Oil Distillation Flasks.....*R. M. Wilhelm*

The emergent-stem corrections for a type of thermometer much used in creosote-oil distillation were determined for four types of flasks in common use. Emergent-stem correction tables based on these results are given. Some other sources of error affecting the temperature measurements are considered. The magnitude of the error in the results of distillation tests, due to neglecting the emergent-stem corrections, is shown. A method is suggested for determining the total corrections under working conditions of thermometers in distillation flasks by observing the readings of the thermometers successively in the vapors of naphthalene and of anthracene, when these substances are boiled in the flasks. (Aug. 14, 1915.) 21 pp. Price, 10 cents.

T50. Viscosity of Porcelain Bodies High in Feldspar. . . . . .*A. V. Bleininger and C. S. Kinnison*

The degree of softening of previously fired porcelain bars under a tensile stress of 14.5 pounds per square inch and at temperatures between 1275° and 1380° C was determined for a series of 18 compositions. The elongation of the specimens was used to obtain data for selecting such mixtures of clay, flint, and feldspar which would show the greatest rigidity at the kiln temperatures and hence cause least loss due to deformed ware. (Sept. 25, 1915.) 7 pp. Price, 5 cents.

T51. Use of Sodium Salts in the Purification of Clays and in the Casting Process. . . . . .*A. V. Bleininger*

An investigation was made of the effect of small quantities of sodium carbonate and sodium silicate in separating impurities from kaolins and in reducing the water content in raw porcelain mixtures composed of kaolin, ball clay, feldspar, and quartz. This mixture is ground together in water to form a suspension which is used to cast clay wares. The effect of the alkalies upon different American kaolins and clays used in the pottery industry was determined with reference to the viscosity of the clay suspensions, the absorption of the reagents, the strength of the treated mixtures in the dried state, and the influence of time on the stability of the system. The effect of the different clays upon each other was also studied. (Sept. 25, 1915.) 40 pp. Price, 15 cents.

T52. Electrolysis and Its Mitigation. . . . . .*E. B. Rosa and Burton McCollum*

The paper gives a brief general statement regarding electrolysis and corrosion and presents a detailed discussion of the various methods of electrolysis mitigation that have been proposed or tried for protecting underground structures. Methods of mitigation are treated under two heads, namely, those applicable to pipes and those applicable to the railway return system. The conclusion is drawn that while certain of the methods applicable to pipes, particularly pipe drainage and insulating joints, are often valuable, they should in general be used as auxiliary measures only, the chief reliance being placed on reducing potential drops in the railway return to reasonably low values. Where return feeders are necessary for accomplishing this, insulated feeders are preferable because more economical. In the last chapter there is presented a discussion of the principles on which regulations concerning electrolysis mitigation should be based, and the responsibilities of owners of underground utilities as well as of the railway companies are emphasized. (Dec. 27, 1915.) 143 pp. Price, 30 cents.

T53. An Investigation of Fusible Tin Boiler Plugs. . . . . .*George K. Burgess and Paul D. Merica*

A report is made of the investigation and tests of about 1100 fusible tin boiler plugs furnished by the courtesy of the Steamboat-Inspection Service, Department of Commerce. The types of failure or deterioration of the used plugs were studied and classified, and investigation made by thermal and chemical analysis of the purity of the tin in such plugs, both new and used. Oxidation of impure tin was found to be the main cause of failure. Conclusions are reached regarding specifications for fusible plugs and the testing of the purity of the tin in them. Zinc, even in quantities as small as 0.3 per cent, was found to be detrimental. (Oct. 15, 1915.) 37 pp. Price, 20 cents.

T54. Special Studies in Electrolysis Mitigation. III. A Report on Conditions in Springfield, Ohio, With Insulated Feeder System Installed. . . . . .*Burton McCollum and George H. Ahlborn*

This report dealing with electrolysis mitigation in Springfield, Ohio, reviews the earlier work done there and describes the general conditions affecting electrolysis and the insulated return feeder system as finally installed. The data taken during the last survey are presented, with a description of

the methods employed, and these data are compared with those taken during the preceding winter given in another report. See T27.] The effect of frost is evident in the potential difference and pipe current data. Cost data showing that the operation expense is slightly greater than before any mitigation system was installed but less than with the first mitigation system are given, and recommendations concerning construction and administration, with the object of maintaining the present satisfactory conditions, are offered. The report contains 25 tables and 13 figures. (Feb. 5, 1916.) 64 pp. Price, 25 cents.

T55. Special Studies in Electrolysis Mitigation. IV. A Preliminary Report on Electrolysis Mitigation in Elyria, Ohio, with Recommendations for Mitigation..... *Burton McCollum and K. H. Logan*

From data furnished by the city and the Cleveland Southwestern & Columbus Railway Co., the feeding distances of the Elyria power house are found to be too long and the potential gradients too high. It is recommended that the gradients be reduced to 0.3 volt per 1000 feet average for 24 hours by the addition of a substation, the interconnection of the tracks of the two electric railways, and the installation of an insulated return feeder system.

The saving in power due to the reduced feeding distance is shown to be more than sufficient to pay the annual charges on the additional investment of $34,373. The plan provides for 800 kilowatts additional substation capacity, improved operating conditions, and substantial elimination of electrolysis. (Jan. 22, 1916.) 49 pp. Price, 20 cents.

T56. Protection of Life and Property Against Lightning ..... *O. S. Peters*

This paper is a report of a survey of statistical data relating to life and property hazards from lightning, and also of existing methods of protection against lightning. The field covered does not include electrical power and signal systems. In the course of the preparation of the paper an examination was made of the available literature on the subjects of lightning phenomena and protection against lightning and of the reports of fire marshals and insurance companies. A considerable amount of data was also obtained from reports of the Census Bureau. Manufacturers of lightning rods were also asked to submit their opinions and the results of their experience as to how a system of lightning rods should be installed. Appendices are included, giving rules concerning the installation and maintenance of lightning rods which have been in some cases followed in England, Germany, and the United States, and also rules for first-aid treatment in cases of persons injured by lightning. (Dec. 15, 1915.) 127 pp. Price, 35 cents.

T57. Difference in Weight Between Raw and Clean Wools..... *Walter S. Lewis*

The term "shrinkage," as used in this paper, is the total loss, by weight, of all grease and dirt. This refers to wool fleeces exclusive of the skirts. It is the commercial practice to leave from 1 to 3 per cent of the natural-wool grease in scoured wool.

The difference between the percentage shrinkage and 100 gives the percentage of clean wool. Forty-nine fleeces were thoroughly scoured and the fiber then extracted of all grease and dirt. The shrinkages varied from 19.5 to 54 per cent according to the breed of sheep.

Shrinkage determinations of each fleece, upon samples which in each case represented an average of the whole fleece (exclusive of the skirts), showed differences as great as 6 per cent, with an average of 1 per cent. The difference in shrinkage between two fleeces of the same breed was 9.5 per cent in one case and an average of 4.5 per cent in 13 different fleeces. The results obtained are given in detail in tables. (Sept. 28, 1915.) 5 pp. Price, 5 cents.

T58. Strength and Other Properties of Concretes as Affected by Materials and Methods of Preparation....*R. J. Wig, G. M. Williams, and E. R. Gates*

This paper is a collation of the results of about 20 000 tests of mortars and concretes made with about 300 aggregates consisting of limestone, granite, gravels, and trap rock. It shows the effect with age on compressive strength, modulus of elasticity, and yield point of varying the proportions of cement to coarse and fine aggregate, the consistency of the mixture, the workmanship in fabricating, the condition of storage, and the value of void, gradation, and density tests. The greatest value of this paper is in emphasizing the necessity of having a knowledge of all the materials used in fabricating concrete and the necessity of exercising extreme care in every phase of the manufacture if a concrete of known quality is to be produced. Both Fuller's method of graduation to a "theoretical curve" and the "void" method of proportioning the constituents of concrete to obtain maximum strength were found to be incorrect. With the percentage of cement to total aggregate fixed, the strength varies as the density of the mixture. (June 20, 1916.) 172 pp. Price, 35 cents.

T59. Standard Test Specimens of Zinc Bronze (Cu 88, Sn 10, Zn 2)—Parts I and II.....*C. P. Karr and Henry S. Rawdon*

PART I.—Preparation and Specifications.....*C. P. Karr*

This paper is a report of work done at the Bureau of Standards upon the standardization of zinc-bronze test bars. In this investigation it was endeavored to ascertain the most suitable methods of molding, mixing, melting, and pouring test bars of this material and to make a record of their physical properties, such as tensile strength, ductility, and hardness, and to study the effect of heat treatment upon these properties. From a study of the results of the investigation tentative specifications were prepared for the preparation of such a bronze.

PART II.—Microstructure.....*Henry S. Rawdon.*

Part II continues the study of the properties of the zinc bronze (Cu 88, Sn 10, Zn 2) already described in Part I. The microstructure and its influence upon the physical properties are discussed in detail. The properties of the bronze were found to be influenced most by the presence of inclusions of foreign matter; this is particularly true of oxides which often occur in the form of thin films separating otherwise sound material. The change of structure accompanying heat treatment is also discussed. A series of typical photomicrographs illustrates the main points of the structure observed. (Mar. 15, 1916.) 67 pp. Price, 25 cents.

T60. Microstructure of Changes Accompanying the Annealing of Cast Bronze (Cu 88, Sn 10, Zn 2).....*Henry S. Rawdon*

The microstructure of commercial brasses and bronzes changes materially upon annealing. The aim of this study is to show the various stages through which the metal passes in going from the cast condition to the annealed or "recrystallized" state and the conditions necessary for these changes. The alloy Cu 88, Sn 10 Zn 2 is used as a type. The observations show that "recrystallization" follows only distortion of the structure; although, in effect, such distortion may be produced by very sudden cooling of the metal. The results obtained very materially substantiate one of the two main theories of the "recrystallization" of metals upon annealing. (Jan. 25, 1916.) 17 pp. Price, 10 cents.

T61. Some Foreign Specifications for Railway Materials: Rails, Wheels, Axles, Tires.....*G. K. Burgess and P. D. Merica*

Statistics, gathered through the Department of State, on specifications for rails, wheels, tires, and axles are given for several European countries, together with a discussion and digest of same, as well as some accident statistics. (Apr. 20, 1916.) 132 pp. Price, 25 cents.

T62. Modern Practice in the Construction and Maintenance of Rail Joints and Bonds in Electric Railways . . . . . *E. R. Shepard*

The paper gives a historical and descriptive discussion of all types of modern rail joints and rail bonds. This is followed by a compilation and analysis of data submitted by 42 electric-railway companies in answer to inquiries sent out by the Bureau. Modern practices and tendencies are discerned and discussed and some recommendations made. (Mar. 10, 1916.) 123 pp. Price, 35 cents.

T63. Leakage of Currents from Electric Railways . . . . . *Burton McCollum and K. H. Logan*

In this paper the theory of the leakage of current from electric-railway tracks is developed mathematically. Assuming, first, a single track of uniform construction and, later, a track whose sections vary in conductivity, leakage resistance, and loading, the effects of rail and leakage resistance and of the length of the line on the distribution and amount of leakage current are calculated for systems with both grounded and ungrounded negative buses. (Mar. 14, 1916.) 31 pp. Price, 10 cents.

T64. Determination of Barium Carbonate and Barium Sulphate in Vulcanized Rubber Goods . . . . . *John B. Tuttle*

When barium sulphate only is used in rubber compounds, the amount present is readily ascertained by determining the total amount of barium present. If barium carbonate is used, it is necessary to separate the two salts. By means of tests made on compounds of known composition prepared at the Bureau of Standards, a method has been devised which permits the quantitative determination of barium carbonate in the presence of either lead sulphate or barium sulphate, the two sulphates most commonly used in rubber goods. The accuracy of the determination is satisfactory for all practical purposes. (Jan. 21, 1916.) 5 pp. Price, 5 cents.

T65. Determination of Oil and Resin in Varnish . . . . . *E. W. Boughton*

Some existing methods include precipitation of "gums" by petroleum ether and extraction of oxidized films with chloroform to dissolve out the resin, or both of these steps. It is shown that these methods give erroneous results with certain types of varnish. Determination of the glycerol yield and calculation of the oil content therefrom gave fairly satisfactory results except with varnish that contained Chinese wood oil. The proposed method included saponification of the varnish, separation of unsaponifiable matter, and separation of fatty acids from resin acids by the Twitchell or Wolff methods of esterification. Ethyl ether is used as solvent after esterification. A correction is applied for resinous matter that is weighed as fatty acids. The greatest error in the average results with the proposed method was 2.2 per cent, expressed as percentage of the varnish. (Feb. 19, 1916.) 32 pp. Price, 10 cents.

T66. Detection of Resin in Drier . . . . . *E. W. Boughton*

For the detection of resin in drier, three steps are proposed: (1) The Liebermann and Storch test for rosin; (2) treatment of the mixture of unsaponifiable matter, fatty acids, and resin acids obtained from the drier with 97 per cent alcohol (if the drier contains much Kauri or similar resin, a turbidity or insoluble deposit will result); (3) esterification by absolute alcohol and concentrated sulphuric acid with subsequent titration with alkali. (If the resulting acid number—mg of KOH per gram of the mixture of unsaponifiable matter and acids taken—is over 10, resin is present in the drier. By this procedure resin can be detected where the amount is at least 6 per cent.) (Jan. 15, 1916.) 9 pp. Price, 5 cents.

T67. Some Qualitative Tests for Gum Arabic and Its Quantitative Determination . . . . . *C. E. Waters and J. B. Tuttle*

A study of many of the published tests for the gum, as well as a research for others than the few that proved to be reliable. It was found that basic lead acetate gives the most characteristic reaction, while mixtures of copper sulphate and sodium hydroxide and of neutral ferric chloride and alcohol are of value as confirmatory tests. Dextrin and gum ghatti were subjected to the same tests.

A summary of the more important methods that have been proposed for the quantitative estimation of gum arabic is next given, followed by a description of the steps that led the authors to the use of alcoholic copper acetate-ammonia solution for this determination.

NOTE.—The greater part of this paper is a compilation, but in no other place known to the authors are so many qualitative and quantitative methods brought together with the corresponding references to the literature. (Jan. 31, 1916.) 15 pp. Price, 5 cents.

T68. Standardization of Automobile-Tire Fabric Testing . . . . . *Walter S. Lewis and Charles J. Cleary*

(1) Definite information was obtained as to the common methods of testing tire fabric; (2) series of comparative tests were made to determine which method would give most reliable results for each particular physical property; (3) variations in test results were found to be due chiefly to different testing machines, size of test specimen, moisture in test specimen, method of sampling, and lack of uniformity of the fabric; (4) to give best results (*a*) testing machines must be calibrated often, (*b*) in size the tensile-strength test specimens should be 1 inch wide, in strip form, and clamped between jaws 3 inches apart, (*c*) test specimens to be bone-dry when breaking stress is determined, and (*d*) test specimens should be selected to give an average of the full width and length of fabric. (Mar. 17, 1916.) 18 pp. Price, 10 cents.

T69. Determination of Carbon in Steels and Irons by Direct Combustion in Oxygen at High Temperatures . . . . . *J. R. Cain and H. E. Cleaves*

A method for the determination of carbon by direct combustion in oxygen, finishing at temperatures above the fusion point of the oxides formed, has been devised. By this method it is shown that the probable error affecting the certificate results of carbon on the Bureau's standard analyzed irons and steels is negligible for present uses of these samples. (Feb. 18, 1916.) 10 pp. Price, 5 cents.

T70. Durability of Stucco and Plaster Construction . . . . . *R. J. Wig, J. C. Pearson, and W. E. Emley*

Many inquiries received regarding the causes of failures and the probable life of "stucco" as used in residence construction has led to an investigation of stucco construction by the Bureau in cooperation with an advisory committee composed of representatives from technical and industrial organizations and a number of expert contracting plasterers. The plans of this committee materialized in the erection in 1915 of a test structure 200 by 26 by 24 feet, containing 56 stucco panels, representing practically all the common types of stucco construction. In April, 1916, a careful inspection was made of the test panels, and only two were found to be entirely free from cracks. About 40 per cent of the panels were found to be in more or less satisfactory condition, the remainder being in various stages of deterioration. While the committee do not feel justified in drawing general conclusions at the present time, much information of value can be obtained from a study of this first progress report. (Jan. 31, 1917.) 74 pp. Price, 15 cents.

T71. Effect of Certain Pigments on Linseed Oil..*E. W. Boughton*

The effect of storage of white-lead and linseed-oil paste on the constants of the oil is shown. Effect of storage of mixtures of various pigments with linseed oil on the constants of the oil is shown. An examination was made of oils from partially oxidized films of pigment and linseed-oil mixtures. The action of linseed-oil fatty acids on white lead and white zinc was investigated. The relative effects of certain pigments on the oxidation of linseed oil in paint films are shown. (Apr. 13, 1916.) 16 pp. Price, 5 cents.

T72. Influence of Frequency of Alternating or Infrequently Reversed Current on Electrolytic Corrosion.....*Burton McCollum and G. H. Ahlborn*

This paper describes experimental work done to determine the coefficient of corrosion of iron and lead in soil with varying frequencies of alternating or reversed current with 60 cycles per second as the highest frequency and a two-week period as the lowest, some direct-current tests being made as a check on the methods. The results show (1) that a decrease of corrosion occurs with an increse in frequency; (2) that the corrosion is practically negligible below a five-minute period; (3) that there is a limiting frequency above which practically no corrosion occurs; (4) that certain chemicals affect the natural and electrolytic corrosion of the two metals quite differently; (5) that the loss of lead in soil on direct current is about 25 per cent of the theoretical loss; and (6) that alternating or reversed current with as long periods as a day or a week would in the case of iron materially reduce the damage to underground structures.

The importance of these results grows out of the fact that there are large areas in practically every city in which the polarity of the underground pipes reverses with periods ranging from a few seconds to an hour or more, due to the shifting of railway loads. The investigation shows that the corrosion under such conditions is much less than has generally been supposed. (Aug. 15, 1916.) 31 pp. Price, 10 cents.

T73. Data on the Oxidation of Automobile Cylinder Oils.....*C. E. Waters*

A study of the rate of oxidation of three automobile-cylinder oils when exposed to sunlight and air. The increase in weight, acidity, and carbonization value, as well as changes in the Maumené and iodine numbers and in the demulsibility, were determined. Changes in the carbonization values of these three oils and of eight others, when heated for different lengths of time at a given temperature and for the same time at different temperatures, were studied. The bearing of the work upon the testing of oils is pointed out. (May 31, 1916.) 20 pp. Price, 5 cents.

T74. Investigation of Cartridge-Inclosed Fuses.....
E. B. Rosa, H. B. Brooks, Burton McCollum, W. J. Canada, and F. W. Glading

This report represents the results of the investigation carried out by the Bureau of Standards acting as referee on the joint request of the Economy Fuse & Manufacturing Co. and Underwriters' Laboratories (Inc.) on the question of the relative fire and accident hazard of Economy refillable fuses and fuses at present listed as standard by Underwriters' Laboratories (Inc.).

The evidence on which the decision was based includes a large number of tests of fuses under widely different conditions, as well as inspections of numerous fuse installations in practice, personal interviews with many fuse users, evidence and arguments submitted by the Economy Fuse & Manufacturing Co. and Underwriters' Laboratories (Inc.), both at a public hearing and by correspondence, and evidence and arguments submitted by a number of manufacturers of fuses at present listed as standard by Underwriters' Laboratories (Inc.).

The question was carefully considered in its various aspects by a committee of technical experts of the Bureau of Standards and has been decided solely on the technical questions at issue.

The question submitted for decision was as follows: "Has it been shown that the use of the fuses manufactured by the Economy Fuse & Manufacturing Co. results in no greater fire or accident hazard than the use of other cartridge-inclosed fuses at present listed as standard by Underwriters' Laboratories (Inc.)."

The Bureau's investigation resulted in the following finding:

"It has not been shown that the use of the fuses manufactured by the Economy Fuse & Manufacturing Co. will result in no greater fire or accident hazard than the use of inclosed cartridge fuses at present listed as standard by the Underwriters' Laboratories (Inc.).

"On the other hand, the evidence in the case does not show that the use of Economy fuses has on the whole resulted in any greater fire or accident hazard than is involved in the use of standard inclosed cartridge fuses." (Dec. 1, 1916.) 199 pp. Price, 55 cents.

T75. Data on Electric Railway Track Leakage....*G. H. Ahlborn*

This brief report gives data and calculations on the leakage and roadbed resistance of three trolley lines of simple geometrical form and having different types of roadbed, elevations, and soil conditions. The leakage varies from 28 to 93 per cent of the total current flowing in lines having about the same length, but one having rather high-resistance roadbed and low-resistance track and the other low-resistance roadbed and high-resistance track. The unit resistances of both rails and roadbed are calculated from data on the different lines. The results corroborate figures of the resistance of soil and roadbed as determined by the Bureau of Sandards by methods of direct measurement on short lengths of track. (Aug. 22, 1916.) 22 pp. Price, 10 cents.

T76. Determination of Volatile Thinner in Oil Varnish.. .....*E. W. Boughton*

With samples of varnish containing turpentine or "mineral spirits" (light petroleum oil), methods based on (1) steam distillation, (2) on evaporation of the thinner from a film at 115° C, and (3) on evaporation of the thinner from a very thin film at room temperature, were all found to be sufficiently accurate for practical purposes. The results should be reported as the whole percentages next above the figures obtained. (June 21, 1916.) 6 pp. Price, 5 cents.

T77. Density and Thermal Expansion of American Petroleum Oils.....*H. W. Bearce and E. L. Peffer*

This paper gives an account of the experimental investigation on which are based the density and volume tables of C57 of the Bureau of Standards, entitled "United States Standard Tables for Petroleum Oils." (Aug. 26, 1916.) 26 pp. Price, 10 cents.

T78. Properties of the Calcium Silicates and Calcium Aluminate Occurring in Normal Portland Cement.....*P. H. Bates and A. A. Klein*

The three constituents of normal Portland cement (tricalcium silicate, dicalcium silicate, and tricalcium aluminate) have been prepared in pure form. From these, after grinding, tensile specimens of both neat and 1:3 standard mortars have been prepared and tested at various periods up to one year. The strengths developed by these pure compounds have been determined, their setting properties, rate, and amount of hydration. These compounds have also been mixed in various proportions and the same data determined. It is intended to show in this paper the function of each of these constituents in normal Portland cement and how each affects the various properties. (June 9, 1917.) 38 pp. Price, 25 cents.

T79. Properties of Some European Plastic Fire Clays... .....*A. V. Bleininger and H. G. Schurecht*

The properties of five well-known European plastic fire clays used in the manufacture of glass refractories, graphite crucibles, etc., have been studied. The content of shrinkage and pore water, the drying shrinkage, fineness of grain, mechanical strength in the dried state, the Atterberg plasticity

number, rate of vitrification, and softening temperature have been determined. A comparison is made of these materials as to their suitability for several purposes, and tentative specifications are suggested for the selection of clays which might be used as substitutes for these foreign materials. American clays are available which, if used as mixtures, can take the place of the imported ones with equally as good or superior results. (Aug. 24, 1916.) 34 pp. Price, 10 cents.

T80. Constitution and Microstructure of Porcelain . . . *A. A. Klein*

A petrographic microscopic study of laboratory-prepared porcelain bodies, of kaolin, feldspar-kaolin, and feldspar-quartz mixtures burned at various known temperatures, and of commercial porcelains representing the practices of United States, England, Germany, France, Austria, Denmark, and Japan. It has been found possible to correlate the constitution of a porcelain with its burning temperature so that the latter may be predicted with an error not greater than 25° from the microscopical examination of a fragment of porcelain much too small for even a chemical analysis. (Dec. 8, 1916.) 38 pp. Price, 25 cents.

T81. Liquid-Measuring Pumps . . . . . *F. J. Schlink*

On the design, installation, inspection, testing, and sealing of the types of measuring pumps in use, for the guidance of weights and measures officials. (Oct. 27, 1916.) 27 pp. Price, 15 cents.

T82. Failure of Brass. 1.—Microstructure and Initial Stresses in Wrought Brasses of the Type 60 Per Cent Copper and 40 Per Cent Zinc . . . . . *Paul D. Merica and R. W. Woodward*

An investigation has been made of the causes of failure of a number of articles, particularly bolts, of wrought brass of the type 60:40, with particular reference to the presence of initial stress. In the course of this investigation the physical properties, microstructure, and initial stress distribution have been studied in failed and sound materials from the Catskill Aqueduct construction, the filtration plant of the city of Minneapolis, the Navy Department, and the Panama Canal, and in new material from a number of manufacturers, some 250 materials in all. Failure has occurred (1) as a result of faulty practice in forging bolt heads, flanging plates, etc., (2) as a result of the presence of initial stress, and (3) as a result of service overstress due to drawing bolts up too tightly. An average initial stress of 5000 pounds per square inch is to be regarded as a safe limit for rods and bolts of this type of material under ordinary service conditions, in which the service load is itself not greater than from 5000 to 10 000 pounds per square inch. (Jan. 29, 1917.) 72 pp. Price, 25 cents.

T83. Failure of Brass. 2.—Effect of Corrosion on the Ductility and Strength of Brass . . . . . *Paul D. Merica*

A study has been made of the effect of tensile stress on the electrolytic solution potential of brass to various solutions, the results indicating an increase of emf of about 0.1 millivolts for 10 000 pounds per square inch of stress. An explanation is given, based upon this effect, of the decreased ductility and strength exhibited by brass when corroded while under tensile stress, and describes the growth and extension inward of a fissure in brass under such conditions. (Nov. 14, 1916.) 7 pp. Price, 5 cents.

T84. Failure of Brass. 3.—Initial Stress Produced by the "Burning In" of Manganese Bronze . . . . . *Paul D. Merica and C. P. Karr*

Investigation has been made of the initial stress produced by the burning in, without preheating, of constrained parts of castings of manganese bronze. Results have shown that in general tensile stresses will be produced within the burned-in area equal in value to the true elastic limit of the material. The conclusion is drawn that burning in of such material should not be practiced without thorough preheating or subsequent annealing of the whole casting. (Nov. 17, 1916.) 7 pp. Price, 5 cents.

T85. Manufacture and Properties of Sand-Lime Brick . . . . . *Warren E. Emley*

Gives historical sketch and description of sand-lime brick as a common building material. Describes the process of manufacture and the properties of the resulting product. The tests suitable for sand-lime brick are outlined, and in the appendix is given a description of various plants. It is shown that where sand of good quality is abundant the ability to make brick of the sand is placed within the reach of the user, furnishing a cheap, durable, noncombustible building material which is a home product, with reasonable transportation costs. (Mar. 22, 1917.) 41 pp. Price, 10 cents.

T86. Resistance of an Oil to Emulsification. . *Winslow H. Herschel*

As no suitable test has been described in print, an original apparatus and method of test were devised by means of which the resistance to emulsification could be expressed by a single numerical value. The test here described was adopted by the Federal Specification Board on recommendation of the Interdepartmental Petroleum Specifications Committee, and is under consideration by a committee of the American Society for Testing Materials. (Feb. 17, 1917.) 37 pp. Price, 10 cents.

T87. Recovery of Paraffin and Paper Stock from Waste Paraffin Paper . . . . . *W. H. Smith*

In order to recover the paraffin and paper stock in waste paraffin paper, a process is described utilizing a vertical steam boiler, tanks for receiving the paraffin, and a beater. The waste is pulped with exhaust steam. The wax rises to the surface and the paper stock settles in the boiler. In the beater the stock is treated with an alkaline solution in hot water to remove ink. The residual wax is collected on a metal cylinder, internally water chilled, and partly submerged in the hot water of the beater. Paper prepared from the recovered stock was free from wax and entirely satisfactory. Practically all of the paper stock is recovered, but about 10 per cent of the paraffin is lost. (Dec. 15, 1916.) 4 pp. Price, 5 cents.

T88. Studies on Paper Pulps . . . . . *W. H. Smith*

Samples of paper pulps, each representing a different method of preparation and with one exception of American manufacture, have been examined to determine their chemical properties. These consist of the amount of ash, cellulose, and methoxyl, the yield of furfural and methylfurfural, and the copper number. Using the same pulps, the loss in weight produced by reagents causing oxidation and hydrolysis and the increase in weight when nitrated have been determined. The effects of sunlight, temperature, and ozonized air on the chemical constants obtained with ground wood have been ascertained. (Feb. 9, 1917.) 13 pp. Price, 5 cents.

T89. A Specific Gravity Balance for Gases . . . . . *Junius David Edwards*

An apparatus is described which provides a quick and accurate means of determining the specific gravity of gases. The principle of the method employed is based upon the laws of the compressibility and the buoyant effect of gas. The portable type of apparatus combines simplicity, lightness of weight, convenience in use, and durability, without any great sacrifice of accuracy. (Feb. 23, 1917.) 20 pp. Price, 5 cents.

T90. Structure of the Coating on Tinned Sheet Copper in a Specific Case of Corrosion . . . . . *Paul D. Merica*

A curious case of pitting in tinned sheet-copper roofing has been investigated, the phenomena observed having directed attention to the question of the structure and properties, particularly the corrodibility and electrolytic emf of the tin coating on copper. This coating, approximately 0.01 mm thick, is shown to consist of at least three layers, the inner alloy layers being hard, brittle, and less readily corroded than the tin and the copper itself; they are electronegative to the base copper. An explanation, based upon the galvanic action between the copper and the tin alloy layer, is given of this type of corrosion, and attention is drawn to the consideration of the extent of mechanical abuse received and of the uniformity and thickness of the tin coating as affecting the resistance to corrosion of this type of material. (Apr. 21, 1917.) 18 pp. Price, 5 cents.

T91. Temperature Measurements in Bessemer and Open-Hearth Practice.....*George K. Burgess*

The problem of temperature measurement and pyrometric control of furnace-casting and ingot-teeming temperatures is shown, by a series of observations taken in several steel plants, to present no serious difficulties or uncertainties. The application of the optical pyrometer to steel and iron manufacture is discussed at length. (May 8, 1917,) 29 pp. Price, 5 cents.

T92. Measurement and Specification of the Physical Factors which Determine the Saturation of Certain Tints of Yellow.....
.....*Irwin G. Priest and Chauncey G. Peters*

States and explains a specification, in terms of relative reflecting powers, designed to set a limit to the saturation of tints of yellow in certain particular cases. The method and apparatus used to test in terms of this specification are also described. Data relative to a number of samples of butter and oleomargarine are given. (June 30, 1917.) 11 pp. Price, 5 cents.

T93. Glasses for Protecting Eyes from Injurious Radiations.....*W. W. Coblentz and W. B. Emerson*

This paper gives general information concerning certain newly developed types of glasses which are very opaque to infra-red or so-called heat rays, and hence are suitable for protecting the eyes of glass blowers, ironworkers, etc. It is shown that gold-plated and Corning "Noviweld" glass are the most efficient protection against infra-red rays. Green, bluish-green, and very deep black glasses are also very efficient in obstructing the infra-red. Green, yellow, and amber colored glasses are the most efficient in obstructing the violet and ultra-violet rays. (Second edition, Apr. 4, 1918.) 25 pp. Price, 10 cents.

T94. Effusion Method of Determining Gas Density....
.....*J. D. Edwards*

The results of an investigation of the theory and practice of the effusion method of determining gas density are reported. Recommendations are made for the design and operation of suitable apparatus. The limitations of the method are pointed out. (June 20, 1917.) 30 pp. Price, 10 cents.

T95. Durability of Cement Drain Tile and Concrete in Alkali Soils.....
.....*R. J. Wig, G. M. Williams, and A. N. Finn,*
in cooperation with.....
.....*S. H. McGrory, E. C. Bebb, and L. R. Ferguson*

The use of concrete, particularly for drainage structure, in soils containing quantities of alkalies found in the arid regions of the United States, has been restricted because of lack of confidence on the part of some engineers as to its durability. It was considered advisable to make observations on cement drain tile and mass concrete of known composition which would be exposed under normal service conditions. The results to date indicate that special care should be observed to employ only the best materials and workmanship, and that the present commercial methods of manufacturing cement drain tile should be improved. No conclusions are yet available as to the endurance of mass concrete except to emphasize the necessity of special care in selection and proportioning of aggregates as well as the use of proper methods of fabrication. (Nov. 15, 1917.) 94 pp. Price, 35 cents.

T96. Comparative Tests of Stitches and Seams...*Walter S. Lewis*

The paper describes tests of seams produced by two methods of stitching by the sewing machines most extensively employed. Seams of the double-locked stitch and the shuttle stitch were tested to show their relative strength and other characteristics. (June 25, 1917.) 7 pp. Price, 5 cents.

T97. Some Unusual Features in the Microstructure of Wrought Iron.....*Henry S. Rawdon*

The microscopic examination of different grades of commercial wrought iron shows that the structure of this material is not always as simple as is usually described. Certain grades, if the microscopic examination is properly carried out, show a peculiar characteristic mottled or banded appearance upon etching. This is shown to be associated with a nonuniform distribution of phosphorus within the individual ferrite crystals. The occurrence of this unusual type of microstructure in specimens which failed in service and which had the appearance of "fatigue" breaks suggests a possible relation between this type of structure and failure by "fatigue." (Sept. 20, 1917.) 25 pp. Price, 5 cents.

T98. The Effects of Heat on Celluloid and Similar Materials.....*H. N. Stokes and H. C. P. Weber*

A study of the behavior of celluloid, and of pyroxylin plastics in general, when heated to different temperatures under varying conditions. Decomposition was found to commence in the neighborhood of 100° C, and above this temperature the heat of decomposition may raise the temperature of the mass to the ignition point. At 170° C, decomposition takes place with explosive violence. Pyroxylin plastics can be ignited by momentary contact with bodies having a temperature of 430° C, and upward. The rate of combustion is 5 to 10 times that of poplar, pine, or paper under the same conditions. The vapors evolved during the decomposition of pyroxylin plastics are poisonous and extremely combustible, and may be ignited by the heat of decomposition. (Oct. 15, 1917.) 40 pp. Price, 5 cents.

T99. Gas-Mantle Lighting Conditions in Ten Large Cities in the United States..*R. S. McBride and C. E. Reinicker*

From a careful inspection of about 4500 gas-mantle lamps in service in 10 cities a summary of the condition of mantles, glassware, pilot light, and other particulars was made in order to determine to what extent the customer benefited through periodic maintenance service.

By these observations it is found that a lamp not on regular maintenance is likely to be defective 5½ times as frequently as a lamp which is regularly maintained. Also it is shown that on the average one in three of the lamps on regular maintenance was not in good condition, whereas the defects noted in the lamps not so maintained average more than one for every lamp.

The principal defects in maintenance systems were also investigated and one satisfactory system of estimating the expenses for maintenance work together with a set of unit costs is presented, based upon the analysis of the operation of 10 gas companies. A suggested table of costs for each type of unit is given. (Oct. 29, 1917.) 37 pp. Price, 10 cents.

T100. Determination of Absolute Viscosity by Short-Tube Viscosimeters.....*Winslow H. Herschel*

The Engler and the Saybolt Universal viscosimeters, which are the instruments usually employed in the oil trade, have such short outlet tubes that the equation for the flow through long capillary tubes is not applicable without correction factors. The literature has been carefully reviewed and further experimental work has been done. The conclusion is reached that water is not a suitable liquid for use in finding the relation between viscosity and time of discharge for short-tube viscosimeters, and that Ubbelohde's equation, and all others based upon it, are seriously in error. (Nov. 9, 1917.) 55 pp. Price, 10 cents.

T101. Tests of Large Bridge Columns. *J. H. Griffith and J. G. Bragg*

The investigation gives a comparative analysis of the experimental data found upon 18 large bridge columns when they were tested in the 10 000 000-pound testing machine. The action of each column as a whole was studied in a range of loadings taken to destruction of the members. Numerous observations were made to determine the behavior of lattice bars, pin plates, diaphragms, etc. The causes and effects of initial strain from riveting and fabrication were discussed. (June 27, 1918.) 139 pp. Price, 30 cents.

T102. The Properties of Portland Cement having a High Magnesia Content.....*P. H. Bates*

A series of cements have been burned in the experimental rotary kiln of the Bureau in which the limestone used in the raw material was replaced in part or in whole by dolomite. Cements were thus obtained in which the magnesia content varied from 1.77 to 25.53 per cent. The clinker produced was examined petrographically to determine the constituents present, their amount, and the character of their formation. The clinker was also ground and the usual physical properties of the resulting cement determined. The results obtained show that cements when containing not more than approximately 8 per cent magnesia will produce concretes with satisfactory strength at the end of one and one-half years. At this amount of magnesia, monticellite, and spinel (constituents not present in cement of lower magnesia content) appear; and these cements seem to hydrate with a large increase in volume. (Jan. 19, 1918.) 42 pp. Price, 15 cents.

T103. Typical Cases of the Deterioration of Muntz Metal (60 : 40 Brass) by Selective Corrosion....*H. S. Rawdon*

T104. The Effect of the Size of Grog in Fire-Clay Bodies.. .....*F. A. Kirkpatrick*

The size of grain has considerable influence upon the properties of mortars, concretes, fire-clay refractories, and other materials. The present investigation establishes the effect of the size of the calcined portion, or grog upon the properties of fire-clay bodies within a field of practical sizes. Strength of the raw bodies depended upon a number of factors and did not vary directly with the size of the grog. Strength of burned bodies increased directly with decrease of the size of grog. Other properties determined were resistance to temperature change, porosity, and volume shrinkage. Methods are suggested for proper proportioning of grog for glass pots, saggers, and similar bodies. (Mar. 12, 1918.) 39 pp. Price, 10 cents.

T105. Comparative Tests of Porcelain Laboratory Ware... .....*C. E. Waters*

Comparative tests of two American, two German, and one Japanese ware showed that only the last and one German make stood up well when suddenly heated or cooled. Cracks in the glaze formed under the tongs when hot pieces were picked up. At times the dishes broke. The solubilities in various reagents showed that all kinds were about equally resistant. The stains caused by ignition with ferric oxide are superficial and do not depend upon the formation of easily soluble silicates. (Dec. 10, 1917.) 8 pp. Price, 5 cents.

T106. Stabilized-Platform Weighing Scale of Novel Design.....*F. J. Schlink*

Treating of the theory and design of a new type of check-stabilized weighing scale in which the usual stabilizing element is replaced by a flexible elastic connector, to the end of eliminating practically all of the friction inherent in early stabilizing mechanisms, with the result that the total frictional resistances in the scale are sensibly independent of the position of the load on the platform. By this expedient, the utilization of check-stabilized scales is broadened and the accuracy of this type of weighing device is much increased.

The earlier types of stabilizing elements are illustrated and the limitations of each explained. The paper includes a discussion of the effects of static friction on the indications of scales and the manner in which the elimination of this increases the accuracy of weighing. (Mar. 12, 1918.) 28 pp. Price, 5 cents.

T107. Comparative Tests of Chemical Glassware..... .....*Percy H. Walker and F. W. Smither*

Composition, coefficient of expansion, refractive indices, condition of strain, effects of heat and mechanical shock, and resistance to various chemical reagents were determined on seven kinds of glassware, which bear permanent manufacturers' trade-marks, and which are offered for sale

on the American market. Two of these kinds of glass were of foreign manufacture. The tests, which were intended to furnish information as to the relative values of the different makes of glass for laboratory operations, show that the five kinds of American-made ware are distinctly superior to one of the foreign brands and at least equal to the other foreign brand. (Apr. 5, 1918.) 23 pp. Price, 10 cents.

T108. Ground Connections for Electrical Systems . . . . *O. S. Peters*

An investigation to determine the best methods of grounding electrical systems for the purpose of promoting safety to life, and also to determine the effectiveness of the methods in common use. The ground covered includes laboratory work at the Bureau and field work in cities in different parts of the United States. The main conclusion reached is that for the best degree of safety water pipes should be used for grounding wherever they are available. Where water pipes can not be reached a common ground wire connected to earth at many points offers the next best means of reducing danger from electrical systems. Except in certain favored localities to obtain a good degree of safety by the use of a single driven pipe or plate on an electrical circuit is impracticable. (June 20, 1918.) 224 pp. Price, 30 cents.

T109. Conservation of Tin in Bearing Metals, Bronzes, and Solders . . . . . *G. K. Burgess and R. W. Woodward*

Recommendations are made for means of conserving tin in bearing metals, bronzes, and solders by substitution of other alloys or constituents of the alloys. Tables are also given showing the properties of the substituted alloys. (Mar. 15, 1919.) 9 pp. Price, 5 cents.

T110. The Influence of Quality of Gas and Other Factors upon the Efficiency of Gas-Mantle Lamps . . . . . *R. S. McBride, W. A. Dunkley, E. C. Crittenden, and A. H. Taylor*

The paper discusses the various conditions such as gas quality, gas pressure, gas adjustment, and air adjustment which affect the operation of mantle lamps, and describes the methods and apparatus employed to control these variables and study their separate effects. The results obtained are given and their application to practical operation is touched upon. The work of other investigators upon variouse phases of the same problem is briefly summarized. (Oct. 25, 1918.) 49 pp. Price, 15 cents.

T111. The Compressive Strength of Large Brick Piers. *J. G. Bragg*

The paper comprises the final report on an investigation of the strength of large brick piers, which was conducted in the Pittsburgh laboratory of the Bureau in cooperation with the National Brick Manufacturers' Association. Tests were made on 46 piers 30 inches by 30 inches by 10 feet high, and 4 supplementary piers of the same cross-sectional dimensions by 5 feet high. Transverse, compression, and absorption tests were made on each lot of bricks used. The bricks used were representative of four districts east of Mississippi River. Two or more grades of brick were obtained from each district. Three kinds of mortar were used in the beginning and three grades of bond and workmanship employed throughout the investigation. (Sept. 20, 1918.) 39 pp. Price, 10 cents.

T112. Standardization of the Saybolt Universal Viscosimeter . . . . . *Winslow H. Herschel*

A disadvantage of the Saybolt Universal Viscosimeter, in comparison with the Engler instrument, was that it had not been standardized with respect to its dimensions. The work herein described removes this objection. An equation for calculating viscosity from time of flow has also been derived, by the method described in T100. (April 30, 1919.) 25 pp. Price, 10 cents. (2d Edition.)

T113. Determination of Permeability of Balloon Fabrics . . . . . *Junius David Edwards*

The paper presents the results of an investigation of methods for determining the permeability of balloon fabrics to hydrogen. (July 2, 1918.) 31 pp. Price, 10 cents.

T114. A Portable Cubic-Foot Standard for Gas...*M. H. Stillman*

The paper treats of a new type of cubic-foot standard for measuring gas which because of its combined portability, accuracy, and ease of operation possesses decided advantages over the apparatus of this type commonly in use at the present time. The standard is especially well adapted to the needs of traveling inspectors of gas-meter testing apparatus.

The use of the standard in testing meter provers is much facilitated by a new auxiliary meter-prover scale which may be quickly applied to any prover.

The author was granted a patent, dedicated to the public, on the cubic-foot standard described. (Jan. 28, 1919.) 13 pp. Price, 5 cents.

T115. New Baumé Scale for Sugar Solutions.....
.....*Frederick Bates and H. W. Bearce*

Many different Baumé scales have been proposed and used in the past. At the present time there are still in use in the United States three different scales for liquids heavier than water. Two of these, namely, the Holland scale and the Gerlach scale, are used in sugar work. Neither is adapted to modern requirements. The new table lies between the Holland and Gerlach scales and has three important advantages which should commend it for general use. They are: (1) It is based upon the specific gravity values of Plato, which are considered the most reliable of any available; (2) it is based on 20° C, the most convenient and widely accepted temperature for sugar work; and (3) it is based on the modulus 145, which has already been adopted by the Manufacturing Chemists' Association of the United States, by the Bureau, and by all American manufacturers of hydrometers. (Oct. 30, 1918.) 11 pp. Price, 5 cents.

T116. Silica Refractories—Factors Affecting Their Quality and Methods of Testing the Raw Materials and Finished Ware.....*Donald W. Ross*

This paper consists chiefly of data obtained in research work on silica refractories (raw materials and finished ware). The experimental work consists of heating tests on silica materials, conducted to determine amount, speed and nature of volume, porosity, and specific gravity changes, occasioned in such materials by various heat treatments. Specific gravity determinations on leading varieties of commercial bricks, screen analyses of raw commercial brick mixes, petrographic examinations, and minor tests were also conducted.

Available data relating to manufacture of ware and geology of raw materials have been included. This work is largely a concentration of existing information, but whenever possible, original data have been obtained. In conclusion, a tentative set of specifications, developed from presented data, for the testing of silica refractories is given. (Apr. 19, 1919.) 84 pp. Price, 20 cents.

T117. Toluol Recovery.....
....*R. S. McBride, C. E. Reinicker, and W. A. Dunkley*

This paper gives a description of toluol plant construction and operation, a discussion of the various results which can be obtained, and a brief outline of the cost of carrying out this recovery. A discussion of the relation of toluol recovery to standards for gas service is also given. Typical forms of contracts which the Ordnance Department has used in contracting for the construction and operation of Government owned toluol recovery plants in connection with city gas works are also given. (Dec. 19, 1918.) 60 pp. Price, 10 cents.

T118. A Critical Study of the Ledebur Method for Determining Oxygen in Iron and Steel.
.....*J. R. Cain and E. Pettijohn*

Various sources of error in the Ledebur method, hitherto unrecognized, are described and means for avoiding these are given. Special forms of apparatus and a special procedure are described. The reducibility of oxides likely to be present in steels and irons is investigated. The limited practical use of the Ledebur method is discussed. (Jan. 11, 1919.) 33 pp. Price, 5 cents.

T119. The Ultra-Violet and Visible Transmission of Eye-Protective Glasses.....*K. S. Gibson and H. J. McNicholas*

Eighty-two samples of eye-protective glass have been studied in regard to their transmission of ultra-violet and visible radiations. For each specimen is given the trade name, dealers, color, thickness, per cent transmission curve from 230 to 700 μ, and the total transmission for visible radiations.

Previous work is outlined, methods and agreements discussed, and comparisons made of the various glasses as regards their protection against ultra-violet radiations. (Dec. 19, 1918.) 60 pp. Price, 10 cents.

T120. Tests of Hollow Building Tiles.
.....*Bernard D. Hathcock and Edward Skillman*

The principal tests discussed are those of compression and absorption which together total about 250. Strain readings were taken upon some of these with an 8-inch Berry strain gage for determining the limit of proportionality and the moduli of elasticity. Besides the compressive strengths and moduli of the tiles, the results show the relationships existing between the moduli of elasticity and the compressive strengths, the color of the tiles and their compressive strengths, the colors of the tiles and their moduli of elasticity, the percentages of absorption and the compressive strengths, and the percentages of absorption and the colors of the tiles. (Feb. 8, 1919.) 29 pp. Price, 5 cents.

T121. Strength and Other Properties of Wire Rope.
.....*J. H. Griffith and J. G. Bragg*

The paper presents the results of tensile tests upon 275 wire-rope specimens selected under the specifications of the Isthmian Canal Commission. The specimens ranged in diameter from one-fourth inch to three and one-fourth inches and comprised five of the more common classes used in engineering practice. The laws of construction of the specimens were determined and were used as the basis of the analysis of their physical behaviors under stress. Numerous comparative physical and chemical tests were presented of the wires, fibers, and lubricants used in wire rope construction. (July 16, 1919.) 80 pp. Price, 20 cents.

T122. Tests of Eighteen Concrete Columns Reinforced with Cast Iron.....*John Tucker, jr., and J. G. Bragg*

The paper deals with data obtained from tests of concrete columns of unusual design which were made by Mr. L. J. Mensch, contracting engineer, of Chicago, and tested in the Pittsburgh laboratory of the Bureau of Standards. Tests were made on 18 columns of 13 inches cross section, the lengths varying from 6 to 14 feet. Tests were also made on samples of cast-iron reinforcement and concrete used in their construction. The construction details, methods of testing, and results obtained are fully discussed with a view to ascertaining the suitability of cast iron as a reinforcing material. A formula for variation of strength with length is given.

T123. Physical and Chemical Tests of the Commercial Marbles of the United States.....*Daniel W. Kessler*

An examination of masonry buildings and monuments which were constructed a few decades ago will readily show a great difference in the durability of various types of stone. Many important monuments which were expected to stand for centuries show marked signs of disintegration before one century has passed. Hence a study of the properties of the different deposits of stone is important in order to determine their relative value for use in commerce and in the arts. The relation between the physical properties of stone and its serviceability is not well understood. This investigation is the first step in an extensive program to establish more definitely by laboratory methods the relative value of different deposits of stone for building purposes. (July 15, 1919.) 54 pp. Price, 15 cents.

T124. The Constitution and Microstructure of Silica Brick and Changes Involved Through Repeated Burnings at High Temperatures.....*H. Insley*

The investigation involves a petrographic microscopic study of test cubes and commercial silica brick, some of which had received repeated burnings by use in kilns. Quartz, cristobalite, and tridymite are the main constituents. Small amounts of pseudo-wollastonite (α—$CaO.SiO_2$) and glass are present. Long burning at temperatures slightly less than 1470° C causes the formation of a large percentage of tridymite. Cristobalite characterizes higher burned brick. Quartz first inverts to cristobalite in the fine-grained groundmass and along cracks caused by shattering on heating and then to tridymite if the temperature does not exceed 1470° C. The lime added in grinding aids more as a flux than as a bond. Most of the cementing action in the burned product comes from the interlocking of the quartz, cristobalite, and tridymite crystals. (July 11, 1919.) 31 pp. Price, 10 cents.

T125. The Viscosity of Gasoline.....*Winslow H. Herschel*

The instruments ordinarily employed for finding the viscosity of lubricating oils are not suitable for gasoline, but it was found that the Ubbelohde viscosimeter, designed primarily for use with kerosene, served to determine the viscosity of gasoline accurately enough for commercial purposes. The usual method of estimating the volatility of gasoline from the specific gravity is a rough approximation, and the volatility depends somewhat on the viscosity. (May 5, 1919.) 18 pp. Price, 5 cents.

T126. A Study of the Goutal Method for Determining Carbon Monoxide and Carbon Dioxide in Steels.....*J. R. Cain and Earl Pettijohn*

It is shown that the method does not give the true carbon monoxide or carbon dioxide content of steels but, instead, a fictitious value for these gases, since they appear to be generated by action of the cupric salt on the carbides present. The amount of this action varies with (1) weight of sample relative to amount of solvent; (2) time of boiling solvent; (3) carbon content of the metal. (Apr. 30, 1919.) 8 pp. Price, 5 cents.

T127. Leakage Resistance of Street-Railway Roadbeds and Its Relation to Electrolysis of Underground Structures.....*E. R. Shepard*

Several methods of making electrical resistance measurements on street-railway roadbeds and on experimental roadbeds are described, and the results of such measurements are given in tabular and graphical form. Certain conclusions are reached regarding the best type of roadbeds and the best methods of treating ties where the reduction of stray currents is important. (Oct. 6, 1919.) 39 pp. Price, 10 cents.

T128. Effect of Solar Radiation Upon Balloons.....
.....*Junius David Edwards and Maurice Blaine Long*

This paper describes briefly the effect of solar radiation upon balloons, including measurements of the temperature of balloon fabrics in sunlight, the radiation characteristics of balloon fabrics, the temperature of the gas in the balloon under various conditions, and methods of determining this temperature. The application of these results to aeronautical construction and navigation are pointed out. (June 13, 1919.) 29 pp. Price, 5 cents.

T129. Notes on the Graphitization of White Cast Iron upon Annealing.....*P. D. Merica and J. J. Gurevich*

The annealing or graphitization ranges of temperature were determined for three different compositions of white iron used for car wheels. The temperature of incipient graphitization was about 830 ° C for a 6-hour anneal and about 730° C for a 48-hour anneal. These temperatures were not appreciably affected by the variation of chemical compositions of the samples investigated. Incidentally the results seem to indicate that graphite separates directly from solid solution. (July 12, 1919.) 12 pp. Price, 5 cents.

T130. A Comparison of the Heat-Insulating Properties of some of the Materials Used in Fire-Resistive Construction ..... *Walter A. Hull*

The Bureau of Standards has made a somewhat extended investigation of the heat-insulating properties of materials used in fire-resistive construction. Cylindrical specimens were heated in a suitable furnace, temperatures at different depths in the specimen being measured during the test. The results show that dense, hard-burned clay bodies heat through more readily than more porous ones, and that there is but little difference between porous clays and various concretes in respect to temperature progress. A surprising indication is that limestone concrete showed fire-resistive properties superior to those of other concretes. Temperature progress was shown to be very slow in all gypsum specimens. (Nov. 12, 1919.) 40 pp. Price, 10 cents.

T131. Application of the Interferometer to Gas Analysis ..... *Junius David Edwards*

This paper describes the principle of the apparatus and method, and discusses the calibration. The effect produced upon the observation by variations in gas composition and method of operation are pointed out, and equations are developed for calculating the same. Typical cases in which the interferometer may be used are analyzed in order to determine its suitability. (Oct. 6, 1919.) 19 pp. Price, 5 cents.

T132. Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium with Copper, with Nickel, and with Manganese..... .....*P. D. Merica, R. G. Waltenberg, and A. N. Finn*

Light alloys of three ternary series, aluminum-magnesium-copper, aluminum-magnesium-nickel, and aluminum-magnesium-manganese, were rolled into sheets and tested in cold-rolled condition, after annealing and after heat treatment. The resistance to corrosion in the salt spray test was also investigated. The alloys of the first series were superior to the others in respect to mechanical properties under all conditions, but were not, on the whole, as resistant to corrosion as the alloys of the last series. The heat-treated alloys of the first series are but little inferior in resistance to corrosion to the alloys of the last series. (Oct. 25, 1919.) 11 pp. Price, 5 cents.

T133. Tests of Flexible Gas Tubing..... .....*R. S. McBride and Walter M. Berry*

This paper shows results of various tests on about 30 samples of different kinds of gas tubing. The specifications proposed by the gas associations are discussed, and a modified set of specifications are presented for criticism and comment. (Oct. 27, 1919.) 37 pp. Price, 10 cents.

T134. Experimental-Retort Tests of Orient Coal..... .....*R. S. McBride and I. V. Brumbaugh*

In connection with coke-oven investigations the Bureau of Standards found it desirable to carry out a short series of experimental-retort tests of Illinois coal, to determine the influence of temperature of coking upon the characteristics of the coke and the quantity and quality of gas produced. This work was done at the Sparrows Point plant of the Bethlehem Steel Co., where apparatus was placed at the disposal of the Bureau through the courtesy of the engineers in charge. The gas produced at high temperatures was much greater in volume but lower in heating value than that produced at the lower temperatures, not only because of more complete elimination of volatile matter from the coal, but also as a result of the greater decomposition of the heavier volatile matter into gaseous constituents at the higher temperature. At the lower temperatures the coke was very inferior to that produced at the higher temperatures, but in no case was the temperature maintained as high as is generally used in coke-oven practice. Detailed

results for the series of five tests are given, and a separate series of results on other coals is included, furnishing data given to the Bureau by the Steel Company covering tests made with the same apparatus during the preceding two years. (Sept. 26, 1919.) 10 pp. Price, 5 cents.

T135. Behavior of Wrought Manganese Bronze Exposed to Corrosion while under Tensile Stress..... .....*P. D. Merica and R. W. Woodward*

Specimens of wrought manganese rods were exposed in special test frames for a period of two years to corrosion in water and moist air while at the same time under tensile stress, with the object of determining the maximum safe stresses for this material under these conditions. None of the test specimens fractured within this period under stresses below the proportional limit or below 35 000 pounds per square inch. Two specimens fractured, one under 40 000, the other under 43 000 pounds per square inch tensile stress. (Oct. 6, 1919.) 9 pp. Price, 5 cents.

T136. The Determination of Free Carbon in Rubber Goods.....*A. H. Smith and S. W. Epstein*

The method consists essentially of removing the rubber and much of the organic matter by treatment with nitric acid. Constituents other than carbon which remain and would show ignition losses are removed, in so far as possible, by treatment with various solvents. Because of the attack on carbon by nitric acid, the ignition loss represents about 105 per cent of the carbon originally present. Thus corrected, the results, although not absolutely accurate, are sufficiently so for commerical work. (Aug. 12, 1919.) 8 pp. Price, 5 cents.

T137. Coking of Illinois Coal in Koppers Type Oven... .....*R. S. McBride and W. A. Selvig*

The Bureau of Standards was ordered by the Administration to conduct an investigation of a new coke-oven process suited to utilization of by-products. The test demonstrated that some Illinois coals can be coked in the Koppers type oven without radical change in operating methods for producing coke for use in blast furnaces. The yield of gas and by-products from the Illinois coal is proved excellent, both in quantity and quality. The Bureau of Mines was responsible for the sampling and weighing, including the handling of the coke, analyses of coal, etc. The subject of costs was not discussed in the report, since this depends on local conditions. (Nov. 17, 1919.) 51 pp. Price, 10 cents.

T138. Effects of Glucose and Salts on the Wearing Quality of Sole Leather....*P. L. Wormeley, R. C. Bowker, R. W. Hart, L. M. Whitmore, and J. B. Churchill*

This paper outlines in detail the methods used and results obtained in testing sole leather with and without added glucose and salts. The object was to determine the effects of these materials on the wearing quality. A comprehensive series of actual wearing tests, laboratory machine wearing tests, and chemical tests on both the original leathers and the worn soles was conducted. The results have been correlated in so far as possible. A description of the leathers tested is embodied and all the important data are graphically illustrated. Several interesting and definite conclusions are drawn in the paper, which is the first of a series to be written on the subject. (Oct. 26, 1919.) 38 pp. Price, 10 cents.

T139. Some Tests of Light Aluminum Casting Alloys—The Effect of Heat Treatment..... .....*P. D. Merica and C. P. Carr*

The mechanical properties of a number of different compositions of cast light aluminum alloys have been determined, as well as the resistance of three commonly used alloys to the action of alternating stresses. Comparison was made of the resistance of some well-known alloys to corrosion in the salt spray test. It was found that the heat treatment of cast alloys,

consisting of annealing at 500° C and cooling in air from that temperature followed by aging for several days before testing, produced an increase in the tensile strength and the hardness, with an attendant decrease, usually, in the elongation. The application of such a heat treatment to light aluminum castings seems to have commercial possibilities. (Oct. 24, 1919.) 31 pp. Price, 10 cents.

T140. Constant-Temperature Still Head for Light-Oil Fractionation.....*Frederick M. Washburn*

Methods in use for the fractionation of light oil and the determination of toluene are discussed. An apparatus has been developed and tested which gives exceptionally accurate results. (Oct. 18, 1919.) 12 pp. Price, 5 cents.

T141. An Electrolytic Resistance Method for Determining Carbon .....*J. R. Cain*

Method and apparatus are described for quickly and accurately determining carbon in steel by absorbing in a solution of barium hydroxide the carbon dioxide resulting from direct combustion of the metal in oxygen, and deducing the carbon content from the change in electrical resistance of the barium hydroxide solution. (Dec. 6, 1919.) 21 pp. Price, 5 cents.

T142. Materials and Methods Used in the Manufacture of Enameled Cast-Iron Wares.....*Homer F. Staley*

The sources, methods of preparation, and properties of raw materials used in white enamels for cast iron, and their effects in the enamel composition, are discussed. Methods of calculating enamel formulas and examples of enamel compositions of various types are given. The defects in enamels, their causes and remedies, are discussed from both the theoretical and the practical standpoints. Manufacturing methods and equipment used in compounding and applying the enamels and in making and preparing the castings are described. (Dec. 20, 1919.) 158 pp. Price, 20 cents.

T143. A Study of the Deterioration of Nickel Spark-Plug Electrodes in Service..*H. S. Rawdon and A. I. Krynitzky*

Some unusual as well as some more common types of deterioration which occur in nickel spark-plug electrodes are described. In service an intercrystalline brittleness is produced in the surface metal exposed to the hot gases and to the action of the spark. Sometimes definite "knife-cut" breaks occur in the wires. The brittleness is due to the action of hot reducing gases and to local heating of small areas. The greatly reduced strength of nickel wire when hot permits breaks to occur in electrodes under the relatively slight tensional stresses set up in service. This is particularly true of electrodes which are firmly anchored at both ends. (Jan. 22, 1920.) 16 pp. Price, 10 cents.

T144. The Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots .....*A. V. Bleininger*

The properties of American bond clays are described in detail and expressed through numerical values. It is shown that domestic materials equal to those formerly imported from Germany are available, and any desired combination of properties may be produced by suitable blending. The natural and artificial graphites are discussed, as well as the control of crucible mixtures. It is shown that the desirable quality of German glass pot clay is its low fire shrinkage, and suggestions are made for obtaining similar results with American materials. The compositions, preparation, and casting of semiporcelain and porcelain pots for the melting of optical glass are given. (Jan. 28, 1920.) 52 pp. Price, 10 cents.

T145. Direct Determination of India Rubber by the Nitrosite Method...*John B. Tuttle and Louis Yurow*

The method described by Wesson (B. S. Tech. Paper No. 35) was applicable only to compounds containing new rubber, and even for these was not altogether satisfactory. By suitably varying the procedure, it has been found possible to extend the usefulness of the method to compounds containing reclaimed rubber and substitutes, as well as lampblack and bituminous substances. The method is based upon the formation of rubber nitrosite, which is purified and burned in a combustion furnace. The carbon dioxide formed is calculated to rubber. (Oct. 22, 1919.) 16 pp. Price, 5 cents.

T146. The Cadmium Electrode for Storage Battery Testing.....*H. D. Holler and J. M. Braham*

In the operation and testing of storage cells, it is frequently important to know the individual potentials of the positive and negative plates. No standard method has been recognized. The results obtained with the cadmium electrode are often contradictory. This investigation has been made to determine the reliability of the cadmium electrode, and the errors in measurement to which it is subject. The standard electrode used was the mercurous sulphate half-cell. It was found that the most serious error in using the cadmium electrode is due to polarization. By measuring the potential of the negative plate and computing the potential of the positive plate from this and the cell voltage, the most serious error of the cadmium electrode can be avoided, even when using an ordinary voltmeter. This investigation deals only with the accuracy of the cadmium electrode and does not discuss the cadmium readings with reference to the age or condition of the battery. (Dec. 12, 1919.) 15 pp. Price, 5 cents.

T147. An Apparatus for Measuring the Relative Wear of Sole Leathers and the Results Obtained with Leather from the Different Parts of a Hide. .....*R. W. Hart and R. C. Bowker*

A short paper on the work done at the Bureau of Standards up to the present time on the wear resistance of sole leather in different parts of a bend. No attempt is made to compare the wear resistance of one tannage with another, although several tannages were used in the work on this problem. The development of the laboratory wearing test machine is described, and the results of several comprehensive tests on this subject are given. There are also included in this paper the results of wearing tests made in the field and in the laboratory on the same leather, showing the manner in which the two methods correlate with each other. (Nov. 22, 1919.) 10 pp. Price, 5 cents.

T148. The Ultra-Violet and Visible Transmission of Various Colored Glasses.....
K. S. Gibson, E. P. T. Tyndall, and H. J. McNicholas

Spectral transmission curves for 87 samples of glass, representing over 50 different kinds, mostly colored, are given in this paper. These curves extend from 710 mμ throughout the visible and ultra-violet as far as the specimens show any appreciable transmission. Most of these glasses are of American manufacture, but a comparison is afforded with some samples of Jena glass obtained before the war. Various practical uses to which these glasses are put are indicated, such as ultra-violet signaling, railway signaling, improvement of visibility both for visual and photographic work, protection of the eyes, and selective ray filters. Of special value is their use as filters to obtain monochromatic light from the mercury, helium, or hydrogen lamps. (Mar. 19, 1920.) 27 pp. Price, 10 cents.

T149. Estimation of Nitrates and Nitrites in Battery Acid ..... *L. B. Sefton*

Three methods for the determination of nitrates—the diphenylamine, the "hydrostrychnique," and the brucine—were studied with reference to their use in testing battery acid. It was found that nitrates in dilute acid could not be estimated in the presence of nitrites, but that by means of either the hydrostrychnique or brucine method, nitrates and nitrites could be estimated together. In the absence of iron, either the hydrostrychnique or the modification of the brucine method is recommended for the determination of nitrates and nitrites. In the presence of iron, the original brucine method alone is applicable. The dimethylaniline test was found to be best for the determination of nitrates. (Feb. 24, 1920.) 10 pp. Price, 5 cents.

T150. Physical Tests of Motor-Truck Wheels . . *Charles P. Hoffmann*

In designing class B military truck, it was found desirable to develop a metal wheel having the good qualities of all the wheels on the market. No comparative values were available, however, and there was no time for service tests. The Bureau of Standards was therefore called upon to make laboratory tests. From these data a cast-steel wheel known as the Composite wheel was designed. Tests showed it to be satisfactory in its final form and it was adopted by the Quartermaster's Department. (Mar. 17, 1920.) 61 pp. Price, 15 cents.

T151. Load Strain-Gage Test of 150-Ton Floating Crane for the Bureau of Yards and Docks, U. S. Navy Department..... ..... *Louis J. Larson and Richard L. Templin*

The fact that a floating crane failed under load on the Panama Canal made it desirable to test a 150-ton revolving floating crane built for use at the navy yard, Norfolk, Va. This structure is statically indeterminate and strain-gage measurements were taken under load to determine the stress in the more important members. It was found that the stresses in the deck were low. The maximum stresses in the outer edge of the tower legs are 17 000 compression and 13 500 pounds per square inch tension. The maximum stress in the pintle post is 18 000 pounds per square inch compression. The stresses in the superstructure and in the luffing screws due to the load are not excessive. (Mar. 18, 1920.) 34 pp. Price, 10 cents.

T152. Investigation of the Compressive Strength of Spruce Struts of Rectangular Cross Section and the Derivation of Formulas Suitable for Use in Airplane Design..... *J. E. Boyd*

The experimental work was confined to spruce struts of approximately square cross section. The ratio of $\frac{L}{r}$ varied from 25 to 250. The amount of compression and of deflection under compressive loading was observed for each specimen. About 60 square-end and 25 round-end struts were tested and formulas deduced which gave results agreeing with the experimental values. These formulas apply to struts of any cross section provided it is of uniform section throughout its length. By a careful mathematical analysis a generalization of Euler's formula is obtained, applicable to a type of tapered struts which approximates the tapers used in airplane wing struts. Because of its rational basis, this formula should give reliable values for these important members of the airplane wing structure. (Apr. 10, 1920.) 43 pp. Price, 10 cents.

T153. Area Measurement of Leather..... *Frederick J. Schlink*

This paper deals with the investigation of area-measuring machines used for integrating the area of leather hides and skins. The importance of the problem of area measurement in view of the enormous amount and value of leather handled annually on this basis is indicated. The principles of design involved in typical machines are set forth in detail and an analysis

is made of the sources of the serious errors which commonly exist and of the means available for detecting and correcting them, including a complete outline of procedure for the determination of the performance of the machine tested, with regard to both the accuracy and consistency of its determinations. Numerical data illustrative of the various errors and performance characteristics of typical measuring machines are tabulated in detail. (Apr. 24, 1920.) 47 pp. Price, 10 cents.

T154. Determination of Cellulose in Rubber Goods.....
.....*S. W. Epstein and R. L. Moore*

A method is presented which is readily applicable to the determination of fabric in rubber sheeting, raincoat materials, waterproofed fabrics, spread goods, frictioned and calendered fabrics in general. The results which are obtained by this method have been found to be accurate by analysis of known compounds. The method is shown to be useful in the detection and determination of cellulose in reclaims. The determination and detection of leather, wood, jute, and cork in rubber mixings is also considered. (Feb. 20, 1920.) 16 pp. Price, 5 cents.

T155. Cements for Spark-Plug Electrodes.....*Homer F. Staley*

The use of cements for sealing electrodes into spark-plug porcelain has been found to be attended by serious difficulties in high-temperature engines such as airplanes. Among these are: promotion of oxidation and destruction of the electrode wires by reactions taking place in the cement and between the cement and electrode wires; breaking of spark-plug porcelains caused by difference in coefficients of thermal expansion of electrode wires and porcelain; and cracking of cement, with consequent gas leakage, due to the same cause. A cement composed of silicate of soda and raw kaolin has been found to give little trouble from chemical action. In order to avoid the difficulties attending the use of any form of cement, the use of a mechanical seal at the top of the porcelain has been tried with promising results. (Feb. 21, 1920.) 10 pp. Price, 5 cents.

T156. Metallographic Features Revealed by the Deep Etching of Steel.....
.....*H. S. Rawdon and Samuel Epstein*

Deep etching of steel by concentrated acids may reveal three different structural conditions—chemical heterogeneity (segregation), mechanical nonuniformity (initial stresses), and physical discontinuities within the metal. A marked roughening of the surface indicating chemical heterogeneity is due to the greater solubility of the impurities and the widening and deepening of the resultant pits. Hardened steel balls, highly stressed as a result of the treatment received, will often spontaneously split when deeply etched. Physical discontinuities may exist within the steel, such as internal fractures in steel rails. The metal is in such intimate contact that the defects can not be located by ordinary means. They may be located by magnetizing the polished specimen and then bathing it in a suspension of fine iron dust in kerosene. Subsequent deep etching serves to widen and deepen these preexisting defects. (Mar. 19, 1920.) 24 pp. Price, 10 cents.

T157. An Investigation of the Physical Properties of Dental Materials.....
.....*Wilmer H. Souder and Chauncey G. Peters*

The Surgeon-General of the Army asked the Bureau's assistance in selecting proper dental amalgam. The properties of dental materials and tooth structures were investigated in this research. This paper includes a review of the instruments and tests applied by early investigators, and gives description of more suitable apparatus together with results obtained therefrom. Comparative tests on crushing strength, flow, thermal and chemical expansion, chemical composition, electrode potentials, etc., are included. (May 22, 1920.) 40 pp. Price, 10 cents.

T158. A Peculiar Type of Intercrystalline Brittleness of Copper . . . . . *Henry S. Rawdon and S. C. Langdon*

A copper rod used as cathode in a bath of molten sodium chloride, mild steel being the anode, with an emf of approximately 6 volts was embrittled to a very appreciable extent. No embrittlement occurred when the copper was the anode of a similar set-up. The change of microstructure which occurred in the first case suggests that metallic sodium is formed by electrolysis, which alloys with the copper along the boundaries of the crystals and so induces the brittleness observed. The results throw some light upon brittleness of copper wire and rods which sometimes occurs in commercial practice in the annealing in a bath of fused salt if the copper is in contact with iron or a similar metal. (Apr. 10, 1920.) 5 pp. Price, 5 cents.

T159. Porosity and Volume Changes of Clay Fire Bricks at Furnace Temperatures . . . . . *George A. Loomis*

This investigation is a study of some of the physical properties of clay fire bricks by a comparison of their changes in porosity and volume on heating to different temperatures with the amount of contraction of the bricks under load at furnace temperatures, and with the so-called melting point. It is also found that these porosity and volume changes serve in explaining the failure of fire bricks in use from such causes as insufficient burning in manufacture. (Apr. 26, 1920.) 29 pp. Price, 5 cents.

T160. Effects of Oils, Greases, and Degree of Tannage on the Physical Properties of Russet Harness Leather . . . . . *R. C. Bowker and J. B. Churchill*

Information is presented showing the method of preparing the leather for the different tests, of making the various physical tests and also data and results obtained from these tests. The results indicate that the amount of stuffing content and degree of tannage affect the physical properties, but that the use of mineral oils instead of animal oils in the stuffing content does not affect these properties. (Apr. 17, 1920.) 18 pp. Price, 5 cents.

T161. A Picnometer for the Determination of Density of Molasses . . . . . *W. B. Newkirk*

A picnometer has been designed to determine, with a greater degree of precision than hitherto possible, the density of very viscous materials, such as molasses. A modified form is proposed which permits the removal of the air without the use of heat but with the use of vacuum. The removal of air by heat is shown to be inaccurate due to decomposition of an unknown character. The proper use of vacuum is shown to give, with ease, results correct to within a few hundredths of a degree Brix. (Apr. 6, 1920.) 7 pp. Price, 5 cents.

T162. Extraction of Rubber Goods . . *S. W. Epstein and B. L. Gonyo*

This paper makes a complete study of the various extracts as determined in the analysis of rubber goods. The subject of mixed solvents, namely, carbon bisulphide and acetone, and chloroform and acetone, is gone into in considerable detail. A large number of figures are presented to show the advantage of using such mixed solvents in the analysis of rubber. (Apr. 9, 1920.) 13 pp. Price, 5 cents.

T163. Stresses Caused by Cold-Rolling . . . . . *H. M. Howe and E. C. Groesbeck*

The experimental data here presented show that a given amount of reduction by rolling causes less residual stress in the metal rolled if it is brought about by a large number of light drafts than by a smaller number of heavy ones. This is shown by means of the curvature induced in each of a pair of superposed strips when they are simultaneously reduced in thickness by rolling, with varying reductions. The result is attributed to the greater skin friction between the metal rolled and the face of the rolls with heavy than with light reductions. Because of this greater skin friction more of the reduction occurs through the backward forcing of the deeper-seated layers, and less through the elongation of the surface of the metal in contact with the rolls. (May 18, 1920.) 8 pp. Price, 5 cents.

T164. The Saybolt Viscosity of Blends.....*W. H. Herschel*

The problem often arises to get a blend of definite viscosity from two oils of known viscosity. To reduce the amount of labor involved in cut and try methods, it is desirable to have a table or chart showing the viscosity of a blend of any two oils mixed in any proportions. The problem has been solved by giving a table calculated from a simple formula, with diagrams for estimating the correction factors to be applied under various conditions. (June 18, 1920.) 21 pp. Price, 5 cents.

T165. Enamels for Sheet Iron and Steel.....*J. B. Shaw*

This paper is a general treatise dealing with the technology of the manufacture of vitreous enamels for sheet iron and steel and the application of these to the metals. Sections are devoted to: The properties and preparation of steel for enameling, the characteristics of the various chemicals used in compounding enamels, and the function of each of these in enamel compositions, the preparation of enamels, the various processes used in applying enamels, the calculation of enamel formulas, the physical properties of enamel coatings, and the resistance of enamels to chemical action. (July 22, 1920.) 88 pp. Price, 15 cents.

T166. Laboratory Wearing Test to Determine the Relative Wear Resistance at Different Depths Throughout the Thickness of a Hide.....*R. W. Hart*

A short paper giving the results of laboratory tests on the resistance of sole leather to wear at different depths throughout the thickness of a hide. The results are clearly shown by graphs and they indicate a greater resistance in the inner portions of the hide than in the grain or flesh portions. This difference is explained by the tanning process and by the anatomy of the skin. The structure of the skin is briefly described and several photomicrographs are shown which illustrate the differences in the structure of the leather throughout its thickness. (August 21, 1920.) 7 pp. Price, 5 cents.

T167. An Examination of the Munsell Color System. I. Spectral and Total Reflection and the Munsell Scale of Value.....
I. G. Priest, K. S. Gibson, and H. J. McNicholas

1. Results of extensive measurements of spectral reflection of colored card standards submitted by the Munsell Color Co.
2. Determination of total reflections for sunlight from above curves and relation of these reflections to Munsell value scale.
3. Recommendations for the improvement of the Munsell system.
(Sept. 30, 1920.) 33 pp. Price, 10 cents.

T168. The Color and Spectral Composition of Certain High-Intensity Searchlight Arcs.....
.....*I. G. Priest, W. F. Meggers, K. S. Gibson,*
..... *E. P. T. Tyndall, and H. J. McNicholas*

Quantitative data on the color and spectral distribution of energy of some modern searchlight arcs, together with spectroscopic analysis of the carbons. Methods of measurement are described. (Aug. 12, 1920.) 14 pp. Price 5 cents.

T169. Measurement of Plasticity of Mortars and Plasters
.....*W. E. Emley*

Description of a new instrument designed to measure plasticity, together with a short history of the work leading up to the design of the instrument. (June 28, 1920.) 27 pp. Price, 10 cents.

T170. Pyrometric Practice.....
..*Paul D. Foote, C. O. Fairchild, and T. R. Harrison*

A complete treatise of the practical phases and applications of pyrometry is presented. All general methods of measurement, instruments, use and stardardization of pyrometric apparatus are discussed. The paper is illus-

trated with cuts of modern American instruments. Many tables of data are included and the treatise contains an index for ready reference. (Feb. 16, 1921.) 326 pp. Price, 60 cents.

T171. Automatic Apparatus for Intermittent Testing.. .....*G. W. Vinal and L. M. Ritchie*

This apparatus has been devised to meet the needs of the Bureau in making tests of dry cells and storage batteries, but is applicable to nearly any form of intermittent testing requiring the closing of electrical circuits at regular time intervals. The particular advantages of this type of apparatus for making these tests are: (1) elimination of rapidly moving parts; (2) accuracy of the time intervals; (3) possibility of making a number of different tests simultaneously with the same apparatus. (July 22, 1920). 7 pp. Price, 5 cents.

T172. Cast Iron for Locomotive-Cylinder Parts....*C. H. Strand*

At the request of the U. S. Railroad Administration, the Bureau has investigated the mechanical, chemical, and metallographic properties of a number of packing rings furnished with service mileage records, as well as arbitration test bars, chill test blocks, and miscellaneous samples from various makers.

The results obtained indicate that existing specifications are insufficiently rigid as to requirements for mechanical tests, and a specification is proposed with revisions in accordance with the results of these tests. (Sept. 11, 1920.) 25 pp. Price, 10 cents.

T173. Tests of Bond Resistance between Concrete and Steel..... .....*W. A. Slater, F. E. Richart, and G. G. Scofield*

This paper embodies the results of three investigations made by the Concrete Ship Section, Emergency Fleet Corporation: (1) to study the effect on bond resistance between concrete and steel of the applications of various anticorrosive coatings on reinforcement; (2) to study the length of lap required for effective splicing of reinforcing bars in regions of high tensile stress, and (3) to study the relative merits of different methods of anchoring the ends of stirrups to meet certain conditions which arise in concrete ship construction. All the paints tested (18) reduced the bond resistance. The length of lap for effective splicing was found to be greater than is generally supposed to be necessary. For anchorage of stirrups 270 degree loops were found to be more effective than the other types of anchorage tested. (Nov. 1, 1920.) 66 pp. Price, 25 cents.

T174. Effects of Cal as an Accelerator of the Hardening of Portland Cement Mixtures.....*Roy N. Young*

This paper gives the results of an investigation to determine the value of a new material (Cal) as an accelerator of the hardening of Portland cement mixtures. While the greater part deals with the effect of Cal on the early strength of mortar and concrete, attention is also given to its effect on other properties of Portland cement.

The results show that Cal is an effective accelerator of the hardening of Portland cement mixtures and that it may be used without injurious effects. (Oct. 11, 1920.) 24 pp. Price, 5 cents.

T175. Pouring and Pressure Tests of Concrete..... .....*W. A. Slater and A. T. Goldbeck*

This paper reports two tests. One of the tests consisted in pouring a vertical slab of concrete under conditions designed to make difficult the securing of a satisfactory job of concreting. After the pouring test, the slab was divided into shallow reinforced beams. Tests of the beams showed compressive stresses in the concrete which were higher than the strength of the control cylinders. The second test consisted in measuring the hydrostatic pressure against the sides of forms which were being filled with concrete. The height of the form was nearly 17 feet. With the concrete being poured at the rate of about 5 feet per hour the maximum pressure occurred under a head of about 4 feet of concrete. (Oct. 11, 1920.) 13 pp. Price, 5 cents.

T176. Slushing Oils.....*Percy H. Walker and Lawrence L. Steele*

A description of the general composition, properties, and uses of slushing oils is given. It is pointed out that these nondrying oily materials are intended for the protection of metal parts from corrosion in cases where it is not practicable to galvanize, paint, or coat with some similar permanent protective agent. Comparative tests upon many commercial rust preventive oils are given and a proposed specification has been drawn up. It is believed that satisfactory slushing oils may be purchased upon the results of simple laboratory tests given in the proposed specification. (Oct. 14, 1920.) 23 pp. Price, 5 cents.

T177. Sulphur in Petroleum Oils.....*C. E. Waters*

The origin, identification, and significance of sulphur and its compounds in petroleum are briefly discussed. Two qualitative tests for sulphur are described, after which numerous methods for the determination of that element are taken up.

The paper concludes with a description and discussion of a new method based upon the preliminary treatment of the oil with nitric acid and bromine, followed by ignition with a mixture of sodium carbonate and nitrate. With certain corrections the method gives results comparable with those by the bomb calorimeter method. (Oct. 20, 1920.) 26 pp. Price, 5 cents.

T178. Steel Rails from Sink-Head and Ordinary Rail Ingots.....*George K. Burgess*

Thirty-five converter ingots of the Hadfield sink-head type were sent to Sparrows Point, Md., and rolled into rails in comparison with fifteen Maryland open-hearth ingots of the ordinary type used for making rails. The ordinary ingots were in three groups, each representing a distinct casting practice. A detailed chemical, physical, and metallographic survey was made of the rails from all ingots rolled and of representative ingots and blooms. The investigation demonstrates the superiority of the sink-head type of ingots as to uniformity of properties of rails made from them, certainty of sound steel throughout, and freedom from piping and undue segregation, and a greater portion of the ingot available for rails. (Dec. 15, 1920.) 61 pp. Price, 20 cents.

T179. Electric-Arc Welding of Steel: I. Properties of the Arc-Fused Metal.....
Henry S. Rawdon, E. C. Groesbeck, and Louis Jordan

Fusion welds differ from all other types in that the weld is essentially a casting. A study of the properties of the arc-fused metal is fundamental in the study of arc-welding. The mechanical properties of the arc-fused metal were determined, the very low ductility being a striking feature. The metal changes considerably in composition during fusion, the carbon and other elements being largely removed, a considerable percentage of nitrogen is acquired. The microstructure is characterized by many microscopic plates within the ferrite grains, the exact nature of which has not been determined. They are apparently related to the nitrogen-content. However, the unsoundness of the arc-fused metal is the deciding factor in determining its properties, the change in composition and structure being of relative minor importance. (Nov. 15, 1920.) 63 pp. Price, 15 cents.

T180. Causes and Prevention of the Formation of Noncondensible Gases in Ammonia Absorption Refrigeration Machines.....
.....*E. C. McKelvy and Aaron Isaacs*

The causes of foul gases in ammonia absorption refrigeration machines are leaks of air into the system and attack of the metal in the plant by impure aqua. The former cause is indicated when the foul gas is nitrogen; the latter, when the gas is hydrogen. The corrosion, caused by impurities in the aqua, may be prevented by the addition of sodium or potassium dichro-

mate to the aqua to the extent of 0.2 per cent of the total weight of the aqua charge. A method is given for the quantitative estimation of carbon dioxide, one of the objectionable impurities, in ammonia. (Oct. 25, 1920.) 10 pp. Price, 5 cents.

T181. Colored Wall Plaster ....*Warren E. Emley and Charlotte F. Faxon*

A method has been developed for making a colored wall plaster of any desired color or texture. The plaster consists of gypsum wood-fibred plaster, containing dyed wood fibre. The color is brought out and the texture is produced by surface treatment of the set plaster. (Dec. 15, 1920.) 8 pp. Price, 5 cents.

T182. Effect of Repeated Reversals of Stress on Double-Reinforced Concrete Beams..... .....*W. A. Slater, G. A. Smith, and H. P. Mueller*

Five beams reinforced in top and in bottom were tested. Repeated loads were applied alternately upward and downward. The number of applications of load in each direction varied from 59 000 upon one beam before failure occurred to over 2 000 000 upon another. In the latter case failure had not occurred when the test was discontinued. The computed stresses developed with each application of load were as high as 29 000 lb. per sq. in. in tension in the steel and 2000 lb. per sq. in. in compression in the concrete. The observed stresses agreed fairly well with the computed stresses. (Dec. 20, 1920.) 51 pp. Price, 15 cents.

T183. Notes on Small Flow Meters for Air, Especially Orifice Meters.....*Edgar Buckingham*

Information on the design and use of orifice and other meters for small flows of air (80 liters/minute or less) prepared for the convenience of physiologists and others who may have to use such meters. Contains data for use in selecting or designing suitable orifices, and deduction of the required equation. (Dec. 20, 1920.) 15 pp. Price, 5 cents.

T184. Fire Tests of Building Columns....*S. H. Ingberg, H. K. Griffin, W. C. Robinson, and R. E. Wilson*

The paper contains the results of tests of 106 building columns, when exposed, under load, to a standardized fire test. The usual types of structural steel columns with the various types of protection commonly employed, were tested. Some fire and water tests and a few tests of reinforced concrete columns were included. (Apr. 21, 1921.) 375 pp. Price, 75 cents.

T185. Experiments on Copper Crusher Cylinders..... .....*Alexander I. Krynitsky*

The main problem in pressure testing of powder and ammunition by means of copper cylinders lies in the necessity of precompression of these cylinders before using them for test.

The two main points in the results of these investigations are:

(*a*) For cases where precompression is necessary, a precompression of the cylinders at a pressure of at least 8000 pounds per square inch below the expected maximum pressure can be employed without impairing the ability of the precompressed cylinders to register the maximum pressure in as reliable a manner as would an uncompressed cylinder.

(*b*) It is probably also aging at temperatures within 0°–100° C that makes the compressed copper rather softer. (Feb. 1, 1921.) 32 pp. Price, 10 cents.

T186. Oscillograph Measurements of the Instantaneous Values of Current and Voltage in the Battery Circuit of Automobiles..... .....*George W. Vinal and C. L. Snyder*

This investigation was begun to study the demands upon starting and lighting batteries in the operation of various types of automobiles. By using an oscillograph, photographic records of the current and voltage have

been obtained. In addition to the data relative to the battery requirements, the interpretation of the records has indicated the possibility of using this method for the study of lubrication, and engine problems relating to speed, friction, ignition, compression, and distributor action. Oscillograms obtained for five of the cars measured are shown in the illustrations. The results given are intended to be suggestive rather than quantitative measurements of performance. (May 2, 1921.) 23 pp. Price, 10 cents.

T187. A Study of Test Methods for the Purpose of Developing Standard Specifications for Paper Bags for Cement and Lime.....*Paul L. Houston*

In this study, new test methods are developed for giving numerically the stress and strains that cement and lime bags undergo in service. There is also given a new test for determining the strength of the adhesives used in these bags. This paper also includes ordinary physical and chemical tests, and specifications are drawn up as a conclusion. (Mar. 21, 1921.) 19 pp. Price, 5 cents.

T188. Some Properties of White Metal Bearing Alloys at Elevated Temperatures.....
.....*John R. Freeman, Jr., and R. W. Woodward*

An apparatus is described for determining the yield point and ultimate strength of white metal bearing alloys at temperatures up to 100° C. The results of compression tests and Brinell hardness at temperatures up to 100° C are given for five typical white metal bearing alloys including three tin base alloys, one lead base alloy, and one intermediate alloy which show that the tin base alloys maintain their properties better at elevated temperatures than the lead-containing alloys. The yield point of tin base alloys is not affected by heating for six weeks at about 100° C, but the yield point is lowered in the lead base alloy by heating for two weeks at about 100° C. (Apr. 5, 1921.) 16 pp. Price, 5 cents.

T189. Method for Differentiating and Estimating Unbleached Sulphite and Sulphate Pulps in Paper.....*R. E. Lofton and M. F. Merritt*

A short review of methods recommended at various times for differentiating between unbleached sulphite and sulphate fibers, and a descriptions of a new method for determining the presence and approximate amount of these fibers in pulps or paper. (Apr. 4, 1921.) 18 pp. Price, 5 cents.

T190. "Black Nickel" Plating Solutions.....
George B. Hogaboom, T. F. Slattery, and L. B. Ham

To produce the so-called government bronze finish on military hardware, "black nickel" plating was frequently applied. Investigation showed that for this purpose very complicated solutions were frequently employed and at times great difficulty was encountered in producing uniform results. This paper describes the results of a few experiments upon such solutions and contains recommendations regarding the composition and conditions of operation which will yield satisfactory deposits. (Apr. 4, 1921.) 9 pp. Price, 5 cents.

T191. Some Factors Affecting the Life of Machine-Gun Barrels.....*W. W. Sveshnikoff*

Star gage measurements on six machine gun barrels at various stages of firing indicate that when the life limit is reached exhaustion is due to a combination of the abrasive action of the bullet and the abrasion of gases.

Amorphous martensite on the surface of the bore has been reproduced by the high temperature from an electric arc, its formation being due to the extremely rapid cooling caused by the large mass of cold metal near the highly heated surface.

Cracking of the bore is due to dimensional changes of the hardened brittle surface of the steel resulting from the variations in temperature between separate shots. The cracks originate at irregularities of the surface of the bore. (June 4, 1921.) 27 pp. Price, 10 cents.

T192. Tests of Centrifugally Cast Steel.....*George K. Burgess*

Six castings manufactured by the Millspaugh centrifugal process were examined as to their physical and chemical properties, including hardness, tensile strength, impact resistance, density, internal stress, segregation, soundness, and microstructure, both in the condition as cast and after various heat treatments. This investigation shows the possibilities of substituting heat treatment for forging in this type of casting. (June 7, 1921.) 22 pp. Price, 10 cents.

T193. Design of Atmospheric Gas Burners.....*Walter M. Berry, I. V. Brumbaugh, G. F. Moulton, and G. B. Shawn*

This paper describes the apparatus and methods used for the investigation of burner operation. Several types of gas orifices were investigated and the coefficients of discharge determined. The principles governing air injection are discussed, and examples and curves are shown to illustrate the effect of a change in the gas pressure, specific gravity, and volume of gas. The design of injecting tubes that produced the greatest injection of air was determined. Characteristics of a satisfactory burner are described. The relation between total port area of burners and the capacity of burners is fully discussed. (Sept. 6, 1921.) 62 pp. Price, 15 cents.

T194. A Preliminary Study of Tearing Instruments and Tearing Test Methods for Paper Testing.....
.....*Paul L. Houston*

In this technologic paper a study is made of the relative effect of different sizes of test samples on the tearing strength of paper. Data are presented to show that the larger the test samples, the greater are the values of tearing strength. There is also taken up a study of two types of tearing instruments on the market. The degree of accuracy of each instrument is determined, and the errors are plotted in the form of curves. In the conclusions, the good and bad qualities of these instruments are discussed at length. (July 27, 1921.) 18 pp. Price 5 cents.

T195. Zinc Cyanide Plating Solutions.....
.....*William Blum, F. J. Liscomb, and C. M. Carson*

During the war zinc plating (or electrogalvanizing) was extensively applied for the protection of steel against corrosion. For this purpose zinc sulphate or zinc cyanide solutions may be employed, but the latter produce more uniform distribution of the metal upon irregular shaped parts. This paper describes the results of experiments upon the preparation, analysis, and operation of zinc cyanide plating solutions. (Aug. 17, 1921.) 19 pp. Price 5 cents.

T196. High Fire Porcelain Glazes.....*H. H. Sortwell*

An investigation of a large field of porcelain glazes with varying alumina and silica to determine the limits within which lie high fire porcelain glazes suitable for use on high fire porcelain, chemical porcelain, spark plugs, pyrometer tubes, etc., maturing from cone 10 to cone 16. (Sept. 2, 1921.) 13 pp. Price, 5 cents.

T197. Cementing Qualities of the Calcium Aluminates
.....*P. H. Bates*

The four calcium aluminates ($3CaO.Al_2O_3$, $5CaO.3Al_2O_3$, $CaO.Al_2O_3$, $3CaO.5Al_2O_3$) have been made in a pure condition and their cementing qualities determined. The first two reacted so energetically with water that too rapid set resulted to make them usable commercially. The last two set more slowly and developed very high strengths at early periods. These two aluminates high in alumina were later made in a pure and impure condition in larger quantities in a rotary kiln, and concrete was made from the resulting ground clinker. A 1 : 1.5 : 5.5 gravel concrete developed in twenty-four hours as high strength as a similarly proportioned Portland cement concrete would have developed in twenty-eight days. (Sept. 27, 1921.) 27 pp. Price, 10 cents.

T198. Results of Some Tests of Manila Rope.....
.....*Ambrose H. Stang and Lory R. Strickenberg*

This technologic paper gives a summary of the results of tensile tests of 368 specimens of Manila rope. Most of them represented material submitted on purchase orders for Government departments. They were all three-strand regular lay Manila rope having diameters from ½ inch to 4½ inches. A summary of the results is given in tables and also graphically. A formula is given by means of which the breaking load for any diameter of rope may be estimated. (Sept. 15, 1921.) 11 pp. Price, 5 cents.

T199. Method for Precision Test of Large Capacity Scales.....*C. A. Briggs and E. D. Gordon*

This paper outlines a scientific and systematic method used by the Bureau of Standards for testing railroad master and grain hopper scales. A pointer and scale are arranged for reading the position of the beam; and the errors of the scale are determined from observations made upon the freely-swinging beam. The procedure of the test is explained with the aid of a record form and computation sheet which was developed in connection with the successful application of the method in the field. In the interest of a uniform and efficient method the scheme outlined is recommended for adoption by those who have occasion to carry out tests on large scales where accuracy of a high order is required. (Sept. 24, 1921.) 16 pp. Price, 5 cents.

T200. An Investigation of Oxyacetylene Welding and Cutting Blowpipes with Special Reference to their Economy in Operation, Safety, and Design.....*Robert S. Johnston*

At the request of the War Department the Bureau conducted an investigation of the operation, efficiency, and safety of oxyacetylene welding and cutting blowpipes. Apparatus from fourteen different makers was submitted to tests, developed jointly by the Bureau in cooperation with makers. The blowpipes were tested in a standard manner to minimize personal equation of the operator and secure data which was representative of the blowpipe itself. It developed that the principles upon which the design of such blowpipes should be based were not well understood, and useful conclusions were reached which should be useful to the industry. (Dec. 28, 1921.) 108 pp. Price, 35 cents.

T201. Friction and Carrying Capacity of Ball and Roller Bearings.....*H. L. Whittemore and S. N. Petrenko*

The experiments were undertaken by the Bureau of Standards at the suggestion of the Navy Department to determine the maximum safe load, and the static friction under load, of ball and flexible roller bearings. Tests were made on balls of 1.00, 1.25, and 1.50 inches diameter in grooved races and on rollers 1.25 inches in diameter and 5.25 inches long in flat and cylindrical races. The ratio of friction to load is practically constant and equal to 0.00055 for all three sizes of balls up to a "critical" load which varies with the diameter of ball. A similar "critical" load, 25 000 lb., was found for the roller bearings with a ratio of friction to load equal to 0.00075. (Oct. 6, 1921.) 34 pp. Price, 10 cents.

T202. Results of a Survey of Elevator Interlocks and an Analysis of Elevator Accident Statistics.....
.....*C. E. Oakes and J. A. Dickinson*

This report presents the results of an inspection of the interlocking mechanisms on several thousand elevator landings, the performances being classified into groups on a basis of service and maintenance conditions—a comparison of the advantages and disadvantages of the various types of devices is given, together with causes of breakdown under service. A number of tables of elevator statistics are given, the statistics being further classified as "shaft-door" and "nonshaft-door." A general discussion of the statistics follows. The interlock requirements of the A. S. M. E. Elevator Code are quoted in conclusion. (Oct. 17, 1921.) 30 pp. Price, 5 cents.

T203. Influence of Phosphorus upon the Microstructure and Hardness of Low-Carbon, Open-Hearth Steels. . . . . *Edward C. Groesbeck*

In this investigation, no clear relationship could be established between the phosphorus content, varying within the range 0.008–0.115 per cent which marks the usual limits in plain carbon steels, and the microstructure and hardness as developed in two series of specimens, one of basic open hearth steel and the other of acid open hearth steel, by a series of different heat-treatments because of the marked irregularity in the distribution and grain-size of the ferrite and pearlite grains found present in many of the specimens. This irregularity was traced to the nonuniform distribution of the phosphorus. A cellular-like structure formed in conjunction with the microstructure normal to these steels was studied, and relationship between this unusual structure and the distribution of phosphorus was established. (Nov. 21, 1921.) 33 pp. Price, 10 cents.

T204. Cutting Fluids . . . . . *Eugene C. Bingham*

Cutting fluids are used both to cool and lubricate. When lubrication is the more important, it is generally recognized that fatty oils are superior to mineral oils, although the reason has never been clearly explained. The evidence appears to be that the value of fatty oils is due to their acidity which causes the adhesion to metal to be greater than is the case with mineral oils. If this should prove to be the case it may yet be possible to synthesize an oil which has all of the virtues of lard oil without its obvious defects. (Dec. 21, 1921.) 44 pp. Price, 15 cents.

T205. Tensile Properties of Some Structural Alloy Steels at High Temperatures . . . . . *H. J. French*

Gives the results of determination of tensile strength, proportional limit, elongation, reduction of area, and strength at fracture throughout the range 20 to 550° C for four steels containing about 0.38 per cent carbon, as follows: Plain carbon steel; 3½ per cent nickel steel; 3 per cent nickel, 1 per cent chromium steel; and 1 per cent chromium, 0.2 per cent vanadium steel. Brief reference is made to the type of fractures obtained in testing steels at various temperatures and particular attention is paid to comparison of the tensile properties of these alloys at 550° C. (Dec. 20. 1921.) 18 pp. Price, 5 cents.

T206. Effect of Heat-Treatment on the Mechanical Properties of One Per Cent Carbon Steel . . . . . *H. J. French and W. Geo. Johnson*

The effects of varying time-temperature relations in heat-treatment on tensile, impact properties, hardness, and structure of 1 per cent carbon steel have been studied, including (*a*) effect of temperature variation in hardening, (*b*) time at hardening temperatures both above Acm and between the Ac_1 and Acm transformations, (*c*) effects of tempering steel hardened in different ways and effects of "soaking" just under the lower critical range, (*d*) comparison of oil and water hardening for production of definite strengths. (Dec. 27, 1921.) 31 pp. Price, 15 cents.

T207. Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements . . . . . *George K. Burgess and Raymond W. Woodward*

The mechanical properties and microstructure of 193 experimental heats of steel containing as principal variable elements C, Si, Ni, Al, Ti, Zr, Ce, B, Cu, Co, U, Mo, Cr, and W have been studied. Extremely high tensile properties with excellent ductility and toughness can be obtained from a nickel-silicon steel without the addition of expensive alloying elements. A method is described for the chemical analysis of steels containing zirconium. (Feb. 1, 1922.) 54 pp. Price, 20 cents.

T208. Weighing by Substitution..*C. A. Briggs and E. D. Gordon*

This paper describes a plan for making accurate substitution weighings, applicable either to equal arm balances or compound lever scales, that has been developed in connection with the standardization of large weights of the Bureau of Standards. It has been prepared to meet a demand for an explanation of substitution weighing which has come from practical scale men in the field who have seen the plan used by the representatives of the bureau and who desire to adopt it. The description, however, will also be of interest and value to many workers in engineering and other laboratories who have occasion to weigh large objects accurately. A record form and computation sheet is presented which it will be found advantageous to follow. (Feb. 21, 1922.) 16 pp. Price, 5 cents.

T209. Thermal Stresses in Chilled Iron Car Wheels .....*G. K. Burgess and R. W. Woodward*

A method is described for testing car wheels in the laboratory under conditions approximating the application of brakes on long grades and for measuring the stresses developed in the wheels due to the heating of the tread while the hub is cool. Twenty-eight wheels were tested in this manner, of which 16 failed by cracking in the plate. The maximum stresses measured were approximately equal to the tensile strength of the iron, or about 26,000 pounds per square inch. (Mar. 18, 1922.) 34 pp. Price, 5 cents.

T210. The Redwood Viscometer.....*Winslow H. Herschel*

The Redwood viscometer is the standard instrument in England for determining the viscosity of lubricating oils. By methods of calibration explained in previous papers (T100, T112, T125) the equation was obtained

$$\text{kinematic viscosity} = .00260\, t - \frac{1.88}{t}$$

where t is the time of flow in seconds. This equation makes it possible to calculate tables for converting Redwood readings into readings of any other instrument for which a similar equation has been determined. (Apr. 10, 1922.) 20 pp. Price, 10 cents.

T211. Radiators for Aircraft Engines..... .....*S. R. Parsons and D. R. Harper, 3d*

The characteristics which determine the value of the radiator in discharging its functions are considered in detail. Measurements of air flow through the core, of head resistance, of cooling power, and of geometrical characteristics are described and an exposition given of the relations between these and the conditions under which a radiator operates and its characteristics of form and construction. The work was based on special laboratory investigations, including laboratory tests of over 100 types of radiator core. A detailed record of the performance of these cores is included in the paper. (May 25, 1922.) 184 pp. Price, 50 cents.

T212. Carbon Monoxide in the Products of Combustion from Natural Gas Burners..... .....*I. V. Brumbaugh and G. W. Jones*

Carbon monoxide is liberated with the products of combustion from natural gas burners in quantities that are dangerous to health if the flame is insufficiently aerated and the room is poorly ventilated. The quantities depend upon (1) distance of the utensil above the burner, (2) height of blue inner cone of flame, (3) type of burner, (4) flame characteristic (ratio of volume of primary air injected into burner relative to volume of gas consumed), (5) rate of consumption of gas per hour. No carbon monoxide was found where the distance of the utensil from the burner was such that the blue inner cone of the flame did not touch the utensil. Ventilation is especially important where gas is consumed. A natural gas flame will smother out if the oxygen of the atmosphere has been reduced to about 15.5 per cent. (May 1, 1922.) 20 pp. Price, 10 cents.

T213. Power Losses in Automobile Tires.....
.....*W. L. Holt and P. L. Wormeley*

This paper describes the dynamometer equipment used to measure the power loss or energy dissipated into heat in automobile tires operated under different conditions of axle load, inflation, pressure, speed, temperature, and tractive effort. The influence of these factors on power losses is shown graphically. (May 5, 1922.) 11 pp. Price, 5 cents.

T214. Durability of Cement Drain Tile and Concrete in Alkali Soils: Third Progress Report (1919–20).....*G. M. Williams*

This paper reports the results of inspection in 1919 and 1920 of experimental drain tile and concrete block installations at eight alkali-bearing projects in the West. The investigation has been carried on since 1913, and the conclusions to date are that the best quality of concrete will disintegrate when exposed to severe alkali attacks, and that installations of concrete in soils containing more than 0.1 per cent of salts of the sulphate type should be preceded by an examination of surrounding conditions. (May 19, 1922.) 32 pp. Price, 10 cents.

T215. Durability of Sole Leather Filled with Sulphite Cellulose Extract.....*Roy C. Bowker*

This paper describes the preparation and testing of four lots of leather used to determine the comparative durability of sole leather filled with sulphite cellulose extract and sole leather filled with the ordinary tanning materials, such as chestnut wood extract and quebracho extract. Physical data obtained from actual service tests and chemical analyses of both the new and worn soles are presented. It is concluded that there is no difference in quality between the two leathers as reflected by the chemical analyses, and that sole leather filled with sulphite cellulose extract is as durable as leather filled with chestnut and quebracho extracts. (June 10, 1922.) 6 pp. Price, 5 cents.

T216. Properties of Electrical Insulating Materials of the Laminated Phenol-methylene Type.....
.....*J. H. Dellinger and J. L. Preston*

A study has been made of the electrical properties and some of the mechanical properties of insulating materials of the laminated phenol-methylene type, such as are used in radio apparatus. The measurements include power loss at radio-frequencies, dielectric constant, flash-over voltage, volume and surface resistivity, thermal expansivity, density, moisture absorption, tensile and transverse strength, elasticity, hardness, impact strength, effect of acids and alkalies, and machining properties. The materials studied were Formica, grades M, M–2, P, and R; Bakelite Dilecto, grades XX, X, and Continental Bakelite; Bakelite Micarta, grades 32–X, 21–X, 323, 213, and 21–D; and Condensite Celoron, grades 10, 15, and 20. (July 21, 1922.) 127 pp. Price, 30 cents.

T217. Photomicrography of Paper Fibers.....*R. E. Lofton*

This paper reports an investigation of the efficiency of the incandescent light as a source of illumination in photomicrography, of the value of light filters, of the proper use of the substage condenser and diaphragm, of the advantages of a camera with a long bellows over one having a short bellows, of the value of staining, choice of objectives, etc. The publication contains 30 figures, including 22 photographs and photomicrographs illustrating the points in question. (Aug. 2, 1922.) 22 pp. Price, 5 cents.

T218. Results of Some Compression Tests of Structural Steel Angles.....*A. H. Stang and L. R. Strickenberg*

This article presents the results of compression tests of 170 structural angles, made at the Pittsburgh branch, Bureau of Standards. The object of the tests was to determine the ultimate compressive strength of angles fastened at the ends in such way as would closely correspond to their connections in the construction of transmission towers. There was also tested a series of angles with square ends. An end fixation factor was found to represent satisfactorily the effect of different types of end connections. Using this fixation factor, the average values for large slenderness ratios were well represented by Euler's formula. The results obtained from shorter columns agreed with the experimental and theoretical results of Karman. The effect of eccentric loading was most marked at the slenderness ratios indicated by Karman's theory. (Aug. 3, 1922.) 17 pp. Price, 10 cents.

T219. Effect of Temperature, Deformation, and Rate of Loading on the Tensile Properties of Low-Carbon Steel below the Thermal Critical Range.....*H. J. French*

This paper gives results of tensile tests at temperatures up to 465° C. of several grades of boiler plate, describing special apparatus used. Determination of the effects of cold and blue work on the properties of these steels throughout the range given is described. Included also are results showing the effect of tensional elastic overstrain on the elasticity at different temperatures and its recovery with time. Effects of variation in rates of loading are described, together with a special apparatus, using a motion-picture camera for the work. (Aug. 22, 1922.) 47 pp. Price, 10 cents.

T220. Test of a Hollow Tile and Concrete Floor Slab Reinforced in Two Directions.....
.....*W. A. Slater, Arthur Hagener, and G. P. Anthes*

A slab 48 by 115.5 feet center to center of outer girders was loaded. The slab is divided into 18 panels, of which 6 are 16 feet square, 6 are 16 by 19.25 feet, and 6 are 16 by 22.5 feet. Measurements of deformations in steel and concrete were measured at about 1,600 places. The moments accounted for by stress in the steel were much less than the moments given by theoretical analysis. There was an increase in stress with continuation of a constant load on the slab, but the load was left in place long enough to indicate that this increase would not lead to a critical condition. (Nov. 15, 1922.) 67 pp. Price, 25 cents.

T221. The Magnetic Susceptibility and Iron Content of Cast Red Brass....*L. H. Marshall and R. L. Sanford*

An investigation was undertaken to determine the practicability of using a magnetic method for the quantitative estimation of small proportions, less than 1 per cent, of iron in cast tin red brass. The magnetic properties and microstructure for seven different samples were determined in the cast condition and as annealed at 800° C. for various periods up to 16 hours. The results showed that the magnetic properties were markedly influenced by heat treatment and were not a simple index to the iron content. (Sept. 22, 1922.) 14 pp. Price, 5 cents.

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T222. Relative Usefulness of Gases of Different Heating Value and Adjustments of Burners for Changes in Heating Value and Specific Gravity.....*Walter M. Berry, I. V. Brumbaugh, J. H. Eiseman, G. F. Moulton, and G. B. Shawn*

In connection with an investigation conducted by the Public Service Commission of Maryland to determine the most economic heating value standard for manufactured gas in the city of Baltimore, the Bureau of Standards conducted an extensive series of laboratory tests to determine, primarily, (1) the relative utilization efficiency of gases of different heating value, (2) the extent to which present appliances can be adapted to give good and efficient service with gases of different heating value and composition, and (3) what adjustment in appliances is necessary to give the consumers good and efficient service when different kinds of gases are mixed and there is a variation in the composition, heating value, and the specific gravity of the gas. The report discusses these questions in considerable detail. (Oct. 4, 1922.) 77 pp. Price, 25 cents.

T223. Reclamation of Used Petroleum Lubricating Oils .....*Winslow H. Herschel and A. H. Anderson*

The reclamation of used oils is of increasing importance as a means of waste prevention, and the necessary apparatus is already available. The reclaimed oils will pass the usually accepted tests, but further information is needed in regard to the significance of tests for acidity, sulphur, and resistance to oxidation before it can be decided whether additional tests, and perhaps modifications of reclamation methods, are necessary. (Oct. 21, 1922.) 16 pp. Price, 5 cents.

T224. Rate of Exhaustion of a Closed Tank by a Reciprocating Air Pump.....*Edgar Buckingham*

An equation is deduced for finding the number of strokes of a reciprocating air pump required to exhaust a tank of large volume down to any given fraction of atmospheric pressure, assuming that the piston and valves are tight. The resulting formula shows how clearance and valve loading affect the speed of exhaustion and the final minimum attainable pressure. (Jan. 4, 1923.) 8 pp. Price, 5 cents.

T225. A New Method for Determining the Rate of Sulphation of Storage-Battery Plates..... .....*G. W. Vinal and L. M. Ritchie*

The object of this investigation is to establish, if possible, a speedy and accurate method for measuring the effect of impurities in storage-battery electrolytes. Preliminary experiments, in which small cells were "poisoned" by the addition of substances to be studied, showed that accurate and consistent results were difficult to obtain. Results given in this paper show that it is possible to determine the rate of sulphation of storage-battery plates accurately by successive weighings of the plates immersed in solutions which are maintained at constant temperature. This paper presents only the fundamental theory of the method and the results of experiments on plates immersed in pure solutions. The extension of the work to include the effect produced by various impurities will be reported in a subsequent paper. (Dec. 19, 1922.) 8 pp. Price, 5 cents.

T226. A study of Commercial Dial Micrometers for Measuring the Thickness of Paper..... .....*Paul L. Houston and D. R. Miller*

In this paper a study is made of the mechanisms, calibrations, areas, and parallelisms of contact surfaces and static contact pressures for different readings of nine commercial micrometers. A performance test is made on the nine instruments, and a new instrument is constructed to measure the compressibility of paper under different contact pressures and different size contacts. The results of the performance and compressibility tests show that different results may be expected from thickness tests on the same paper when different commercial micrometers are used because of their different contact pressures and different size contacts. In the conclusions, recommendations are made for the construction of a new standard micrometer. (Dec. 29, 1922.) 28 pp. Price, 10 cents.

T227. American and English Ball Clays.....*H. H. Sortwell*

The properties of the 21 American and English ball clays in use in the largest quantities in the manufacture of white-burning ceramic products were studied. The water of plasticity and volume drying shrinkage relations, amount of coarse mineral matter, strength when plastic, behavior in slips, strength in the dry state, amount of carbonaceous matter, volume and porosity relations over a wide range in temperature, and color in a standard body were determined. Comprehensive data on the clays are given, and a classification based on the properties is included. (Jan. 13, 1923.) 30 pp. Price, 10 cents.

T228. Lathe Breakdown Tests of Some Modern High-Speed Tool Steels....*H. J. French and Jerome Strauss*

Modern high-speed tool steels are classified according to chemical composition. The present general tendencies as regards proportions of those elements present which may be classed as impurities are discussed. These data are based on analysis of about 65 lots representing approximately 40 brands produced by various manufacturers during the period 1919–1922. Comparative lathe-cutting tests are reported for about 25 brands representing various type compositions. The test used is known as the "breakdown test" in which the endurance of tools is measured under fixed working conditions, and a discussion of the behavior of the different groups is given under both moderate and severe service. Measurements of power consumed by various steels in severe tests are likewise reported. A discussion is given of some of the limitations of the competitive breakdown test, and recommendations are made regarding its application. (Feb. 17, 1923.) 43 pp. Price, 15 cents.

T229. Some Tests of Steel-Wire Rope on Sheaves..... .....*Edward Skillman*

All of the ropes tested were marked "plow steel hoisting rope." They varied from 5/8 to 1/4 inch in diameter. One of them had been used for five years, but the others were new. Tests were made to determine the strength of the wires from the ropes, of the straight ropes with socketed ends, and of the ropes when at rest on sheaves of from 10 to 18 inches diameter. The results of the tests are given and the discussion covers the effect of the manner of loading the rope and the effect of overloading on the strength of worn rope. (Mar. 2, 1923.) 17 pp. Price, 10 cents.

T230. A Recording Chronograph for the Inverse Rate Method of Thermal Analysis.....*H. J. French*

This report describes an apparatus designed for direct plotting of curves for the inverse-rate method of thermal analysis, in which the time interval required for a definite temperature change and the temperature are the coordinates. The fundamentals of its construction and operation are described, and examples of typical curves produced are included. There is also given a brief discussion of the advantages obtained by its use, principally in reducing the time required for determining transformations in metals with equal or greater accuracy than when using ordinary types of chronographs. (Mar. 14, 1923.) 11 pp. Price, 5 cents.

T231. Tentative Standard Test Methods and Percentages of Oil and Moisture in Hair Press Cloths... .....*F. R. McGowan and C. W. Schoffstall*

An investigation to set suitable standard percentages of oil and moisture content of hair press cloths. A description of the fabric and its use is given. Methods of procedure for obtaining accurate percentages are outlined and the results of tests on 27 samples are given with graphs illustrating them. (Mar. 10, 1923.) 20 pp. Price, 5 cents.

T232. Shellac.....*Percy H. Walker and Lawrence L. Steele*

A description is given of the source, manufacture, uses, and common methods of testing shellac. Emphasis is laid on the extent to which shellac spirit varnishes are adulterated and the inadequacy of present methods for detecting such adulteration is shown. A new method for detecting adulteration in either flake or spirit shellac is described, and data are given on many samples of different grades. A suggested table for rating shellac samples from the data of this method is given. Recommended methods are given for the determination of such material in shellac as is insoluble in hot alcohol and for the determination of the shellac-alcohol ratio in a spirit varnish. Suggested specifications for pure orange flake shellac and pure orange shellac varnish are given. (Mar. 12, 1923.) 20 pp. Price, 5 cents.

T233. Tests of Heavily Reinforced Concrete Slab Beams: Effect of Direction of Reinforcement on Strength and Deformation..... .....*Willis A. Slater and Fred B. Seely*

Twenty-six slab beams were tested for the purpose of determining the effect of the direction of the reinforcing bars on the stress developed and the relative values of bars and of expanded metal for use as slab reinforcement. An analysis of the mechanics involved indicates greater stresses and deflections for beams with diagonal than for those with direct reinforcement. The test results confirm in a general way the results of this analysis. For the slabs reinforced with expanded metal the distribution of cracks was better than for any of the slabs reinforced with bars. For splicing the expanded metal a lap of about 1.5 diamonds was indicated as being necessary. (Mar. 20, 1923.) 48 pp. Price, 15 cents.

T234. Methods of Measuring the Plasticity of Clays....*F. P. Hall*

Discussion of the term "plasticity" and the methods brought forward for the measurement of plasticity, the factors which each measures, the Bingham plastometer as an instrument for determining relative plasticity of clays, the need for more efficient methods of measuring plasticity. (Mar. 22, 1923.) 22 pp. Price, 10 cents.

T235. Thermal Stresses in Steel Car Wheels..... .....*George K. Burgess and G. Willard Quick*

The paper presents the results of special thermal stress tests made on 33-inch steel car wheels. The wheels were mounted on a hollow water-cooled axle, and the treads were heated to 380° C. by passing an electric current through a soft steel resistor which encircled the wheels. The resulting stresses were calculated from strain-gauge measurements after correcting for thermal expansion. The manner in which thermal stresses build up in wheels, the magnitude, nature, and location of the stresses are given. The wheels withstood the tests satisfactorily, and a few tested to 500° C. showed no sign of failure. The maximum stresses developed were in the extreme fibers and approximated the elastic limit of the steel. (Mar. 24, 1923.) 37 pp. Price, 15 cents.

T236. Loading Test of a Hollow Tile and Reinforced Concrete Floor of Arlington Building, Washington, D. C. . . *Louis J. Larson and Serge N. Petrenko*

Hollow tile and reinforced concrete panels supported on reinforced concrete beams were loaded, some to 3.8 times the design live load. Maximum stresses were those developed in slab at positions of negative moment. The effect of continued loading was well marked in the first 20 hours and comparatively small later. The beams around the edges of panels offered little resistance to torsion. The cracking of concrete and the resulting great increases of stresses in reinforcing steel showed that concrete carried considerable proportion of tensile stresses. The moment coefficients were generally small, due to low stresses, and are not proposed for design but show the relative amount of bending moments carried in both directions. The factor of safety of the construction is apparently higher than two. (Apr. 21, 1923.) 41 pp. Price, 15 cents.

T237. Aeronautic Instruments. . . . . *Franklin L. Hunt*

This paper discusses briefly the types of aircraft instruments which have reached a state of practical development such that they have found extensive use in practice. The instruments described include: *Altitude instruments*, such as altimeters, barographs, statoscopes; *speed instruments*, such as air-speed indicators, ground-speed indicators, rate-of-climb indicators; *orientation instruments*, such as compasses, turn indicators, inclinometers; *engine instruments*, such as tachometers, pressure gauges, gasoline gauges, gasoline flow indicators, thermometers; *navigating instruments*, such as maps, dead-reckoning instruments, astronomical instruments, radio direction finder; and *special instruments* and accessories, such as oxygen instruments, recording instruments, strut and gas temperature thermometers, time pieces, manometers, hydrogen leak detectors. (May 16, 1923.) 65 pp. Price, 20 cents.

T238. Some Compressive Tests of Hollow-Tile Walls. . . . . *Herbert L. Whittemore and Bernard D. Hathcock*

Thirty-two tile walls, 4 feet long and 12 feet high, built of exceptionally high strength tile, were tested in compression. The walls fall into groups according to the size of tile, the construction, and the method of loading. The latter was axial for all but six walls for which the load had an eccentricity of 2 inches. About half of the walls were built with the cells vertical and the others with the cells horizontal. Tile from Ohio and from New Jersey were used. Walls with the cells vertical were stronger than where the cells were horizontal. The maximum stress sustained was quite independent of the wall thickness and the total load nearly proportional to this thickness. The walls axially loaded failed under a stress which was about one-third as large as was developed in the single tile. The eccentrically loaded walls developed only about half as great a stress as the centrally loaded specimens. (July 21, 1923.) 15 pp. Price, 5 cents.

T239. Tests of Caustic Magnesia Made from Magnesite from Several Sources. . . . . *P. H. Bates, Roy N. Young, and Paul Rapp*

Magnesite ores from four different sources, including both the crystalline and amorphous varieties, were calcined under various conditions and prepared for use in oxychloride cement mixtures. Each lot of cuastic magnesia was tested in three flooring and two stucco formulas under actual service conditions as well as in the laboratory. The properties of chief interest were time of set, strength, linear change, and water resistance. The various ores used require different conditions of calcination in order to produce caustic magnesias of a given quality. The properties of the cement mixtures are affected to a very great extent by variations in (1) The degree of calcination of the ore; (2) type of aggregate, and (3) the relative amounts of given constituents in a mixture. (Sept. 14, 1923.) 30 pp. Price, 10 cents.

T240. Dynamometer Tests of Automobile Tires.....
.....*W. L. Holt and P. L. Wormeley*

This paper relates to a continuation of the work described in Technologic Paper No. 213, Power Losses in Automobile Tires. Dynamometer tests have been made on a large number of tires of different makes, and large differences have been found in their properties. A study has been made to determine the cause of these differences and point out their significance. (Sept. 24, 1923.) 23 pp. Price, 10 cents.

T241. A Comparison of the Deoxidation Effects of Titanium and Silicon on the Properties of Rail Steel.....*George K. Burgess and Willard Quick*

The paper gives the results of a comparison of rail steels finished with additions of ferrotitanium and ferrosilicon in the ladle. The study included the following out of the manufacturing processes of melting, teeming, and rolling of rails; tests on samples from the top and bottom ends of A rails for chemical homogeneity and soundness, various mechanical properties, and a macroscopic and microscopic survey. The results show much less segregation and somewhat greater uniformity in physical properties at the top ends of A rails treated with titanium. At the bottom ends there was practically no evidence of improvement from titanium additions as compared with silicon. Improvements by the additions of titanium seem to be mostly confined to the top portion of the ingot. (Oct. 1, 1923.) 57 pp. Price, 10 cents.

T242. Detector for Water Vapor in Closed Pipes.....
.....*E. R. Weaver and P. G. Ledig*

The electrical resistance of a thin film of a hygoscopic electrolyte is used as an approximate measure of the water vapor in the atmosphere with which the film is in contact. The detector is a very simple device easily adapted for use in high-pressure piping and other situations in which the determination of water vapor is usually attended with difficulty. Laboratory experiments showing the reliability, method of application, and limitations of the device are described. (Oct. 1, 1923.) 8 pp. Price, 5 cents.

T243. Stresses in a Few Welded and Riveted Tanks Tested Under Hydrostatic Pressure.....
.....*A. H. Stang and T. W. Greene*

For the purpose of ascertaining the relative merits of riveted, as compared with electric-welded tanks, four steel tanks, 4 feet in diameter and 10 feet long, were tested under hydrostatic pressure. The ends of the tanks were spherical, having a radius of 4 feet. Strain-gauge measurements were made at different pressures and the stress distribution and the stress-pressure relationship obtained. The results of the hydrostatic tests proved rather unsatisfactory for comparing the relative strengths of the different types because of secondary failures. Secondary stresses, which produced failure in each case, were caused by (*a*) faulty design of the attachment of the spherical end to the cylindrical shell, (*b*) nonconformity of the shell to an accurate circular section, and (*c*) discontinuities in the shell for the manhole and fittings. (Oct. 13, 1923.) 24 pp. Price, 10 cents.

T244. A Measure of the Color Characteristics of White Papers.....*R. E. Lofton*

Describes a method by which the color characteristics of white papers may be determined in terms of the capacity of the paper for diffusely reflecting red (625 mμ wave length), green (550 mμ wave length), and blue (460 mμ wave length) light. Gives the color characteristics for 21 samples of papers of various kinds, and shows that all samples tested are more or less deficient in the proportion of blue lights reflected. A table of the relative whiteness of the 21 samples as determined by 17 individuals by unaided eye observation is also included. (Nov. 17, 1923.) 10 pp. Price, 5 cents.

T245. Embrittlement of Malleable Cast Iron Resulting from Heat Treatment.....*Leslie H. Marshall*

The investigations detailed in this paper have shown that commercial malleable cast iron is embrittled to a greater or lesser degree, depending on the iron, by quenching from certain temperatures in the "blue-heat" range, such as are obtained in the hot-dip galvanizing process. This embrittlement is lessened by slow cooling, but is not affected by subsequent aging. The fundamental cause of this behavior is not known. The embrittlement can be eliminated, however, by heating to 650° C. (1,200° F.), for a few minutes. (Nov. 26, 1923.) 17 pp. Price, 5 cents.

T246. Wet-Process Enamels for Cast Iron.....
.....*R. R. Danielson and H. P. Reinecker*

This paper deals with an investigation of enamels to be applied to cast iron by the wet process, both with and without ground coats. The effects of variations in the compositions of ground coats, white cover enamels, and both colored and white single-coat enamels have been studied. Suitable technic for the preparation and application of the enamels is discussed. A number of satisfactory compositions for ground coats, white-cover enamels, and single-coat colored enamels have been developed. It has been found that white enamels applied directly to the iron are not as satisfactory as the white cover enamels applied over a so-called ground coat. (Dec. 19, 1923.) 41 pp. Price, 10 cents.

T247. A New Electrical Telemeter.....
.....*Burton McCollum and O. S. Peters*

This paper describes the underlying principles and development of an electrical telemetric device with special reference to its application to remote reading and remote recording gauges for measuring strains, stresses, and pressures that may be either steady or rapidly varying in value. For their operation these instruments depend upon the displacement-resistance characteristic of a stack of carbon plates, a mounting for the plates having been devised that permits a calibration sufficiently accurate and dependable for many engineering measurements. (Jan. 4, 1924.) 41 pp. Price, 15 cents.

T248. Exposure Tests on Colorless Waterproofing Materials.....*D. W. Kessler*

This paper describes a series of tests of several colorless waterproofing materials on different types of natural stone. The tests were made to determine the relative effectiveness of the materials, their durability under exposure to the weather, and their effect on the appearance of the stone.

The results indicate that certain types of waterproofing materials are quite effective in preventing the absorption of water and some of these showed practically no deterioration during the two years covered by the tests. (Jan. 7, 1924.) 33 pp. Price, 15 cents.

T249. Thermal-Conductivity Method for the Analysis of Gases.....*P. E. Palmer and E. R. Weaver*

Methods for the rapid analysis of gas mixtures have come more and more into use during recent years. Of the various physical characteristics of gases which offer possibilities for the development of gas-analysis instruments, the thermal conductivity is probably the most useful. By a comparison of the resistance of two electrically heated wires surrounded, respectively, by the gas for analysis and a reference gas, a determination is possible of the concentration of certain constituents in a wide variety of gas mixtures of importance in industry and research. High sensitivity and great accuracy are secured at a relatively small expense and the method is well adapted for either manual or automatic continuous operation. By the use of suitable auxiliary devices various automatic-process controls based on gas composition are easily arranged. (Jan. 7, 1924.) 66 pp. Price, 20 cents.

T250. Pulp and Paper Fiber Composition Standards: Reference Standards, Showing the Color Reactions of Common Paper-Making Fibers and Standard Fiber Mixtures with Various Stains for Use in Identification and Estimation of Fiber Composition of Paper.....*Muriel F. Merritt*

In standardizing the microanalysis of paper fibers there are no colored charts or plates of 100 per cent pure pulps or standard percentage mixtures of standard pulps. This publication covers eight fiber compositions and one plate of the color reactions produced by the stains. Standard pulps and pulp compositions used in the estimation of fiber content were selected for the micrographs, different stains being used to bring out various characteristics of the fibers. The four stains employed were Delafield's hematoxylin, malachite green, Hersberg stain, and the Lofton-Merritt stains. A list of the water colors that matched the stained fibers is given. (Apr. 25, 1924.) 5 pp.; 9 pl. Price, 15 cents.

T251. Equalizer Apparatus for Transverse Tests of Bricks.....*H. L. Whittemore*

The American Society for Testing Materials has described the apparatus to be used for making transverse tests of building bricks. As this apparatus is made of many loose parts considerable time is required to prepare the next specimen for test. A new equalizer apparatus has been designed, built, and tested which gives practically the same values for the modulus of rupture as the A. S. T. M. apparatus. The time required for testing with this new apparatus was found to be 58 per cent of that required if the A. S. T. M. fixture was used. (Feb. 5, 1924.) 7 pp. Price, 10 cents.

T252. The Nick-Bend Test for Wrought Iron.....
.....*Henry S. Rawdon and Samuel Epstein*

The nick-bend test is included in most specifications for wrought iron, the character of the fracture being the criterion by which the material is judged. A crystalline fracture is usually regarded as indicative of inferior material. Most specifications are lax in regard to the method of breaking the nickel bar, either pressure or blows being permitted. This investigation, based upon 12 different grades of iron, was primarily for showing how the character of the fracture varies with the method used, and also the real meaning of the test. In brief, the results showed that in many specifications the nick-bend clause is meaningless and should either be eliminated or redefined. (Feb. 29, 1924.) 41 pp. Price, 10 cents.

T253. Standardization of Hosiery Box Dimensions.....
.....*Charles W. Schoffstall and E. M. Schenke*

Present hosiery boxes are represented by photographs and a series of graphs which show waste, defects in packing, breakage, etc. A list of the proposed standard dimensions is given for men's, ladies', and children's hosiery boxes. It is estimated that a reduction of 76 to 83 per cent of the number of present sizes will result from the adoption of these standards. A new method of packing men's hosiery is shown. The results to be obtained from the adoption of standard hosiery boxes are discussed. (Mar. 1, 1924.) 13 pp. Price, 10 cents.

T254. Emissive Tests of Paints for Decreasing or Increasing Heat Radiation from Surfaces.... .....*W. W. Coblentz and C. W. Hughes*

Data are given on the emissivity of sheet iron, cotton duck, roofing material, artificial leather, etc., covered with white paint, vitreous enamel, aluminum paint, etc. A coat of aluminum paint emits only 30 to 50 per cent as much thermal radiation as white paint, vitreous enamel, or other nonmetallic surfaces.

The data are of interest in reducing the heat emitted from the under side of roofs, awnings, tents, automobile tops, etc.

As applied to house radiators, which are convectors of heat, a gain of 15 to 20 per cent in heat dissipation may be expected by covering the surface with a paint which is free from flakes of a metal, such as aluminum or bronze. (Mar. 13, 1924.) 17 pp. Price, 5 cents.

T255. A Camera for Studying Projectiles in Flight..... .....*H. L. Curtis, W. H. Wadleigh, and A. H. Sellman*

A camera suitable for obtaining a number of pictures of a rapidly moving object is described. The number of pictures per second which can be taken is very large, depending on the number of lenses which are used in the construction of the camera. In addition, the time between pictures can be accurately determined. By means of this camera it is possible not only to take a number of pictures of a rapidly moving object, like a projectile, but also to determine its velocity. (Mar. 19, 1924.) 14 pp. Price, 10 cents.

T256. Some Methods of Testing Radio Receiving Sets.. .....*J. L. Preston and L. C. F. Horle*

This paper describes some methods of testing regenerative and nonregenerative radio receiving sets. Data obtained from these tests should assist the manufacturer to describe his products accurately and the buyer to make a careful comparison of characteristics of commercial receiving sets. Methods are given for determining the frequency range, ruggedness, sensitivity, and selectivity of receiving sets. A summary of data from measurements of sensitivity and selectivity are also presented. (Mar. 26, 1924.) 26 pp. Price, 10 cents.

T257. Development of a Method for Measurement of Internal Stress in Brass Tubing..... .....*Robert J. Anderson and Everett G. Fahlman*

This paper describes a new method for the quantitative estimation of longitudinal internal stress in tubing; that is, cold-drawn brass condenser or similar tubing. Examination of many samples of cold-drawn brass tubes showed that the major stress is longitudinal and that the usual cutting methods applies for estimating internal stress which have been used in the case of rods and bars were not suitable for tubes. The method described in the paper for measuring longitudinal internal stress is called the strip method, and is carried out by slitting a narrow strip longitudinally in a piece of tubing; that is, a strip 2.75 inches long and 0.10 inch wide in a 3.25-inch tube length, and then releasing one end of such a slit strip by cutting. From amount of the springing of the strip the stress can be calculated. (May 23, 1924.) 13 pp. Price, 5 cents.

T258. Strength of Steel Tubing Under Combined Column and Transverse Loading, Including Tests of Columns and Beams.....*Tom W. Greene*

A number of tests, ranging from that of a column with no transverse load to that of a beam with no column loading, were made on steel-tubing struts for the purpose of obtaining experimental data to check the theory for combined column and transverse loading. The results show that the eccentricities of a strut, which were measured, resulting from variation in wall thickness and deviation from straightness must be taken into account in determining the strength. The commonly used formulas for axial load struts do not represent actural strut condition, but a modified rational formula based on these eccentricities was found to fit the experimental results closely. The paper considers various formulas for columns and for struts under combined column and transverse loading. (May 23, 1924.) 34 pp. Price, 15 cents.

T259. Saturation Relations in Mixtures of Sucrose, Dextrose, and Levulose.....
.....*Richard F. Jackson and Clara Gillis Silsbee*

The article describes the influences exerted by each of the constituent sugars on the solubilities of sucrose and dextrose. Invert sugar, dextrose, and by inference, levulose, diminish the solubility of sucrose in water to an important degree. Similarly sucrose or levulose diminishes that of dextrose. The compositions of invert sugar which are saturated with dextrose at various temperatures are tabulated and designated the "solubilities of invert sugar." All commercial honey is shown to be supersaturated with respect to dextrose. The degree of supersaturation in each instance has been calculated. The compositions of the sugar mixtures, which are saturated with sucrose and dextrose and contain dextrose and levulose in equal proportions, have been computed for various temperatures. Such solutions possess the maximum solubilities which mixtures of sucrose and invert sugar may have. (June 17, 1924.) 28 pp. Price, 10 cents.

T260. Tests of Some Girder Hooks.....
.....*Herbert L. Whittemore and Ambrose H. Stang*

Curved mild-steel hooks having rectangular cross sections, designed for 5, 10, and 15 tons, were loaded, using several increments, up to the proportional limit of the material.

The stresses on the inside and on the outside surfaces of the hooks were measured experimentally with strain gauges having 2-inch gauge length. Readings were taken along practically the entire length of the hooks.

The stresses were computed theoretically by adding algebraically the component normal to a right section of the hook and the stress due to bending at that section.

The stresses (at the critical section of the hook) were computed by the Winkler-Bach and the Andrews-Pearson formulas. The experimental and theoretical stresses were plotted and compared with the values obtained from the formulas. It was found that the experimental and theoretical stresses agreed very well.

The stresses obtained from the Winkler-Bach and the Andrews-Pearson formulas which take into account the curvature of the hook gave correct values for the stress at the critical section.

As these values were in no case more than 20 per cent greater than the experimental stresses, the use of the more exact formulas is not necessary in designing hooks of this type if a sufficiently large factor of safety is used. (June 28, 1924.) 21 pp. Price, 10 cents.

T261. Influence of Sulphur, Oxygen, Copper, and Manganese on the Red-Shortness of Iron....*J. R. Cain*

Small ingots have been made (approximately 900 g) of electrolytic iron and, in some cases, Armco ingot iron, with additions of copper, manganese, oxygen, and sulphur. Forging tests of the specimens have shown that red-shortness is absent between 1,100 and 500° C. if sulphur is below 0.01 per cent. If sulphur does not exceed this amount, oxygen in amounts up to 0.20 per cent is without effect on red-shortness. The effect of copper in the amounts studied (0.05 to 0.5 per cent) was of minor importance, but tended toward correcting red-shortness. Some data are given on amounts of manganese, needed to prevent red-shortness where sulphur is above 0.01 per cent. (July 30, 1924.) 9 pp. Price, 10 cents.

T262. Comparison of American and Foreign Clays as Paper Fillers....*Merle B. Shaw and George W. Bicking*

Eight representative clays (five American and three foreign) were used in this investigation. Preliminary runs established best method of handling clay and determined constant factors. Comparative runs were made varying the kind and percentage of clay and using both fresh water and machine water. Measurements for clay retention include analyses of samples taken at 13 different positions on the paper machine. Duplicative tests were made in a commercial paper mill. Measurements were also made for physical properties of the finished paper. Tests for physical properties of the clay (color, grit, rate of flow, etc.) were made to find whether any correlation existed between such properties and paper-making qualities. Comprehensive data on all tests are shown comparatively in tables and graphs. (Aug. 20, 1924.) 44 pp. Price, 15 cents.

T263. Tangent Modulus and the Strength of Steel Columns in Tests.....*O. H. Basquin*

This paper contains a review of more than 200 tests of steel columns completed by the Bureau of Standards in 1916 for the American Society of Civil Engineers and the American Railway Engineering Association. The study is made for the purpose of testing the accuracy of a formula for column strength first proposed by Engesser in 1889. The investigation shows that while the formula may not prove to be the final solution of the problem of column strength, it is capable of giving estimates of strength which differ but a few per cent from the actual strengths of columns as found by testing them. (Sept. 18, 1924.) 62 pp. Price, 20 cents.

T264. Development of the Standard Numbered Cotton Duck Specification: Study of Methods of Tests and Tolerances.....
.....*Charles W. Schoffstall and Russell T. Fisher*

A study of various samples of numbered duck, ranging for the medium texture from 2/0 to 6 and for the hard texture from 2/0 to 12, is given. The various test methods are shown. For breaking strength, the strip and three types of grab methods—1 by 1 by 3 inches, 1 by 2 by 3 inches, and 1 by 1 by 1 inch—were used. The 1 by 1 by 3 inch grab method was selected for the standard grab method of test. The results are listed in construction and breaking strength tables and various graphs illustrate the significance of the data. The study of the results show how the specifications were formulated. There are given the final specifications for numbered cotton duck. (Sept. 26, 1924.) 22 pp. Price, 10 cents.

T265. Theory and Performance of Rectifiers.....
.....*H. D. Holler and J. P. Schrodt*

The theory and performance of electrolytic, thermionic, and magnetic rectifiers were studied. The wave form, degree of rectification, and energy efficiency were determined under a variety of conditions. The performance of any rectifier may be represented by a set of curves showing input, output, and energy efficiency as functions of battery voltage. The effect of inductance, capacity, and battery voltage upon the electrolytic rectifier is shown by numerous oscillograms. The variation in efficiency of the magnetic rectifiers was determined under varying conditions of frequency, line voltage, and battery voltage. (Oct. 9, 1924.) 63 pp. Price, 20 cents.

T266. Measurement of Heat Insulation and Related Properties of Blankets...*P. D. Sale and A. F. Hedrick*

The principal factors influencing the heat insulation of fabrics are discussed. Apparatus is described and methods proposed for the measurement of this and other related properties of blankets, viz, permeability to air and water vapor. Standard test conditions are recommended simulating those to which fabrics are subjected in service. Data illustrative of the several tests made on new blankets, typical of the variety to be obtained in the trade, are presented. The heat insulating value of blankets is correlated with thickness, weight, and density of the specimens. It is planned to supplement this paper by a following publication Specifications for Constructing and Operating the Heat Transmission Apparatus, and later by a more thorough analysis of experimental data, only a part of which has been presented herein. (Dec. 5, 1924.) 18 pp. Price, 10 cents.

T267. Effect of Hot-Rolling Conditions on the Physical Properties of a Carbon Steel.....
.....*J. R. Freeman, jr., and A. T. Derry*

The effect of the following five independent variables of rolling conditions, namely, initial temperature, finishing temperature, total reduction, pass reduction, and speed of rolling, on the physical properties of a 0.45 to 0.50 carbon steel were studied. The tensile properties determined were ultimate strength, yield point, limit of proportionality, elongation, and reduction of area. Other properties studied were hardness, resistance to impact, density, and microstructure. The steel was rolled in one direction only in order to determine the effect of unidirectional rolling on the longitudinal and transverse properties. The finishing temperature and total reduction were found to have the greatest influence on the resultant mechanical properties of the steel. The density of rolled steel was found to be practically the same as when in the cast condition. The transverse tensile properties are slightly inferior to the tensile properties in the longitudinal direction. (Oct. 27, 1924.) 20 pp. Price, 10 cents.

T268. A Study of Silk Waste Used for Cartridge-Bag Cloth, with an Appendix on the General Classification of Waste Silk.....
F. R. McGowan, Charles W. Schoffstall, and A. A. Mercier

A study was made of the waste silk used in the spun-silk industry of the country to ascertain if the waste silk purchased by the Government for the manufacture of cartridge-bag cloth (a large quantity of which remained on hand after the war) was suitable for spun-silk manufacture. It was found unsuitable for this purpose, and since this necessitated a continuance of the manufacture of this material on the cotton and woolen systems (as was done during the war) and since, in addition, a large quantity of yarn was still on hand, a commercial use adaptable to the normal requirements was very desirable. A fabric was woven at the bureau using this material as a single yarn, unsized, in the warp direction with a wool yarn in the filling. Tests showed that the resulting fabric was well balanced in relation to wear. The general classes of spun silk are given in an appendix. Photographs of various types of spun silk are shown. (Dec. 4, 1924.) 28 pp. Price, 15 cents.

T269. Specifications for Constructing and Operating Heat-Transmission Apparatus for Testing Heat-Insulating Value of Fabrics.....*P. D. Sale*

These specifications are intended for use by the textile industry, the trade, or others interested in determinations of heat-insulating value of fabrics in general. By their use the average shop man can readily construct the apparatus, and its operation can be easily understood. The apparatus is believed to fulfill the requirements for testing such materials as textile fabrics which are primarily mixtures of textile fibers and entrapped air. The specifications cite certain standard conditions for tests and recommend that tests be made generally under still-air conditions. (Dec. 16, 1924.) 13 pp. Price, 10 cents.

T270. An Analysis of the Deformation of the Mooring Spindle of the *Shenandoah*..... .....*L. B. Tuckerman and C. S. Aitchison*

The results of the examination and tests on the bent mooring spindle of the United States Navy airship *Shenandoah*, to determine the wind force to which the ship was subjected during a storm on the night of January 16, 1924, are reported in this paper. Although the forces which produced a permanent deformation in the structure can not, in general, be determined with accuracy, an approximate method of examination and analysis was developed applicable to any axially symmetrical deformed structure. Among the conclusions reached by this analysis are that the material evidently met specifications for yield point and also that the load, producing deformation, was certainly greater than 13,400 pounds and probably greater than 27,000 pounds. (Jan. 9, 1925.) 10 pp. Price, 10 cents.

T271. Measurement of Electrical Resistance and Mechanical Strength of Storage-Battery Separators.....*C. L. Snyder*

This paper outlines a method for measuring the resistance of storage-battery separators and gives the results of measurements on separators of several kinds of wood. The effect of thickness of the separators, the method of treating them, and the effect of concentration and temperature of sulphuric acid solutions on resistance and mechanical strength of the wood are described. (Jan. 9, 1925.) 16 pp. Price, 10 cents.

T272. Fire Resistance of Concrete Columns..... .....*W. A. Hull and S. H. Ingberg*

The paper reports tests of 78 concrete columns of the types in general use, of which 62 were fire tests and 16 compression tests. The fire resistance is found to be mainly a function of the mineral composition of the concrete aggregates employed, and means are developed for improving the fire resistive properties of columns made with concrete susceptible to the most marked fire effects. (Feb. 24, 1925.) 74 pp. Price, 25 cents.

T273. Performance Tests of a Liquid Laundry Soap Used With Textile Materials.....*F. R. McGowan, F. W. Smither, and Charles W. Schoffstall*

This study was made to compare the properties of a liquid laundry soap with other washing and scouring agents with respect to shrinkage in weight and dimensions, fading of dye, and changes in construction and feel. Tests were run on various textile materials, including knitted fabrics, wool fabrics, mohair yarns, and wool fleeces. The laundry practice was both mild and severe to cover the range of usual practices in laundry operations. It was found that the liquid laundry soap was superior in each of the tests. (Oct. 8, 1924.) 26 pp. Price, 10 cents.

T274. Use of United States Government Specification Paints and Paint Materials.....
.....*P. H. Walker and E. F. Hickson*

A brief description is given of the various materials covered by the specifications. It is believed that the existing specifications are sufficient for practically all necessary painting operations of the Government. The system of using semipaste paint, whenever possible, is recommended, and suitable thinning formulas applicable for the average painting condition have been developed. The proper method of breaking up and thinning stiff pastes in oil, semipastes, and mixed paints is discussed. The practical application of the various paints to all of the ordinary surfaces, such as wood, metal, cement, plaster, concrete, etc., is brought out and recommendations made. The care of brushes and the brushing of paint is described. (Dec. 15, 1924.) 20 pp. Price, 10 cents.

T275. Design of Specimens for Short-Time "Fatigue" Tests.....*L. B. Tuckerman and C. S. Aitchison.*

The controlling factors in the design of specimens are different for the short-time "fatigue" tests and endurance run fatigue tests. In endurance runs it is necessary to secure failure at a place where the stresses are determinate and calculable. In short-time "fatigue" tests failure is not desired.

It is possible, then, to design the short-time "fatigue" specimen with maximum stresses uniform over a large portion of the material, thus securing greater sensibility. This should be the controlling factor in the design of these specimens.

Specimen shapes are shown suitable for different types of short-time "fatigue" tests. Because of the simple specimen shape, the Sondericker type of machine is considered best suited for these tests. (Dec. 22, 1924.) 9 pp. Price, 5 cents.

T276. Compressive Strength of Sand-Lime Brick Walls
.....*H. L. Whittemore and A. H. Stang*

Eighteen sand-lime brick walls, 8 or 12½ inches thick, 6 feet long by 9 feet high and also 18 wallettes, about 18 inches long and 34 inches high, of the same material, were tested in compression. The sand-lime brick were of medium grade. Lime, cement-lime, and cement mortars were used. The average ultimate compressive strength of the thin walls was greater than for the 12½-inch walls. The mortar affected the strength of the walls to a very large degree, the cement mortar walls being three times as strong and the cement-lime mortar walls twice as strong as the lime mortar walls. All the walls were more than twice as strong as required by usual building-code requirements. (Jan. 21, 1925.) 15 pp. Price, 10 cents.

T277. Comparative Wearing Qualities of Pima and Ordinary Cotton Used in Mail Bags...*F. R. McGowan, Charles W. Schoffstall, and A. A. Mercier*

The general characteristics of Pima cotton are discussed, together with the reasons for attempting to find new uses for this type. The purpose of this investigation was to compare mail bags made from Pima cotton with those made from ordinary cotton, in the regular catcher pouch service. The detail organization used for making the yarn is given. The tests and results are described and discussed. The conclusion from this investigation is that Pima cotton mail bags stand the service wear decidedly better than ordinary cotton bags. (Feb. 2, 1925.) 11 pp. Price, 10 cents.

T278. Effect of Twist on the Physical Properties of a Number 7s Yarn.....*F. R. McGowan, Charles W. Schoffstall, and A. A. Mercier*

This investigation was made to determine the most suitable twist to use in making the yarn to be used in the Pima post office bag investigation. Data were obtained on the relation of the twist to the breaking strength, diameter of the yarn, yarn count, contraction, and angle of twist. While the data were not sufficiently extensive to attempt to fix definite formula for these relations, it is thought that the tabular and graphical relation studied in this investigation will be useful for the cotton manufacture. The most suitable twist for the yarn to be used in the Pima mail bags was found to be about 12 turns per inch. (Feb. 11, 1925.) 11 pp. Price, 10 cents.

T279. Testing of Fire-Clay Brick with Special Reference to Their Use in Coal-Fired Boiler Settings.... .....*R. F. Geller*

Fire-clay brick, representative of the product as manufactured in the United States, were obtained through the cooperation of Stone & Webster, together with a report of a field survey covering the service rendered by fire-clay refractories in boiler settings. The refractories were subjected to heat and load tests in the laboratory, were analyzed chemically, and several were examined petrographically. The data presented in the field survey were correlated and the combined results of laboratory test and service tests were compared. As a result of this work the qualifications of high-grade refractories for coal-fired boiler settings are believed to have been established. (Feb. 13, 1925.) 43 pp. Price, 20 cents.

T280. Reclamation of Gasoline Used in Dry Cleaning.... .....*C. C. Hubbard*

This paper outlines and discusses briefly the processes that have been used for the "purification" and recovery of gasoline used in dry cleaning. Results are reported of laboratory and plant experiments and of large scale plant tests. A "settling and decanting" process is recommended, using activated carbon and an aqueous solution of trisodium phosphate. (Mar. 31, 1925.) 13 pp. Price, 5 cents.

T281. Malleability and Metallography of Nickel..... .....*P. D. Merica and R. G. Waltenberg*

In the manufacture of rolled, forged, and sand-cast products, of nickel and nickel alloys, rather unusual metallurgical treatments of the molten metal are resorted to in order that the resulting castings may be malleable in the hammer shop or mill. This investigation has shown that the reason for these special treatments lies in the presence in these alloys of a very small amount of sulphur, the detrimental effects of which are eliminated by the treatment of the molten metal with manganese and magnesium. The structural mechanism of the effect of these treatments is demonstrated and the high temperature chemical reactions involved are indicated. This work was done under an industrial fellowship maintained at the Bureau of Standards by The International Nickel Co. (Apr. 2, 1925.) 32 pp. Price, 10 cents.

T282. Technology of Cotton Machinery. Part I. Calculations on Pickers.....*A. A. Mercier*

Paper consists of calculations on pickers, the machines used in the first processes of cotton manufacturing. The calculations are important because they cover the fundamental data on these machines. These data consist of the r. p. m. of certain moving parts, ratio of one part to another, production resulting when using certain speeds and ratios of speeds, and amount of beating given the cotton. The calculations allow for a wide range of speeds, various size pulleys, and different changes in the weight of the product. They were prepared for the purpose of eliminating waste of time in determining the pulleys and gears to be used to obtain required

speeds, drafts, production, and amount of beating, as well as to give information which can not be had without searching through books or by correspondence. By chart or table, organizations are quickly formed and are most valuable where frequent changes are made. (Apr. 2, 1925.) 30 pp. Price, 10 cents.

T283. Effect of Tire Resistance on Fuel Consumption... .....*W. L. Holt and P. L. Wormeley*

Technologic Paper No. 240 data were given showing the rolling resistance found in various pneumatic tires. These have been compiled, together with similar tests of balloon tires, to show in a concise form the maximum and minimum resistance which may be expected in various types and sizes of pneumatic tires. The values for tire resistance have been compared with other resistances which the fuel used by an automobile is required to overcome, and conclusions drawn as to what extent the total fuel consumption of an automobile can be influenced by the tires. (Apr. 6, 1925.) 11 pp. Price, 5 cents.

T284. A Study of the Seasonal Variation of Radio-Frequency Phase Difference of Laminated Phenolic Insulating Materials..... .....*J. L. Preston and E. L. Hall*

In measurements of radio-frequency properties of laminated phenolic insulating materials, the results of which are published in Bureau of Standards Technologic Paper No. 216, some samples were found to exhibit changes in these properties with time. This led to a more systematic study of a limited number of samples. Incidentally, data on the variation of phase difference with frequency were also secured. From observations made on 13 samples over a period of one year, it was found that the radio-frequency phase difference had a definite seasonal variation. In general, the phase difference returned to its original value after a year's cyclic changes. (Apr. 10, 1925.) 10 pp. Price, 5 cents.

T285. Release of Internal Stress in Brass Tubing..... ..... *R. J. Anderson and E. G. Fahlman*

Results are given on the effect of low-temperature heat treatment on the release of stress and on the physical properties of cold-worked leaded brass tubing. The object was to investigate the possibilities of effecting stress release in cold-worked brass tubing by heating at moderate temperatures without accompanying loss in hardness and strength. It is shown that brass tubing which has been reduced in area by cold working in the range 17 to 56 per cent can be heated over a fairly wide time-temperature range without loss in hardness or tensile strength, but with substantially complete release of internal stress. For the material worked with it was found that heating for two to three hours at 325° C. was suitable. (May 14, 1925.) 31 pp. Price, 15 cents.

T286. Comparative Durability of Chrome and Vegetable Tanned Sole Leathers..... ..... *R. C. Bowker and M. N. V. Geib*

An investigation to determine primarily the comparative wearing qualities of vegetable and chrome tanned sole leathers. Comparative tests were made between vegetable and natural chrome, vegetable and filled chrome, and between natural chrome and filled chrome. Includes a general discussion of the comparative properties of the two leathers, description of the leathers tested, methods used and the results of wear, chemical, and hygroscopic tests. (June 13, 1925.) 20 pp. Price, 10 cents.

T287. A Hot-Wire Anemometer for Measuring Air Flow through Engine Radiators..... ..... *Carl G. F. Zobel and L. B. Carroll*

In connection with various tests on airplane radiators, a portable instrument for the rapid measurement of average air flow over appreciable areas was required. For this purpose, a hot-wire anemometer was constructed which derives its power from a small storage battery. The only electrical measuring instruments required are a voltmeter and an ammeter. The operation, calibration, sources of error, and application of the anemometer offered difficulties which are discussed and analyzed. Line drawings assist in presenting many of the results. It was found that the anemometer could be used to measure free air flow within 3 per cent of the true values if power values of heat dissipation were adjusted for a fixed temperature head. (June 18, 1925.) 10 pp. Price, 5 cents.

T288. Comparative Cold-Rolling Tests of Open-Hearth Steel Strip (Deep Drawing Stock) and Electrolytic Iron Strip..... .....*John R. Freeman, jr., and R. D. France*

A series of tests has been carried out to determine the relative cold-rolling properties of electrolytic iron as compared with open-hearth steel especially adapted for deep-drawing operations. Representative lots of the two types of material were cold-rolled under identical conditions in order to determine any difference in behavior in the rolls. The material was rolled under both mild and very severe rolling practice. No evidence developed indicating any marked difference between the two types of material. The following tests were made on samples representing each step in the rolling: Hardness, Erichsen, tensile, and bend tests. In general, the tests indicate that electrolytic iron would be slightly superior to specially selected commercial open-hearth deep drawing stock. (June 24, 1925.) 17 pp. Price, 10 cents.

T289. Comparative Slow Bend and Impact Notched Bar Tests on Some Metals..... *S. N. Petrenko*

Comparative impact and slow bend notched bar tests were made on some nonferrous alloys and on some steels in order to determine whether the slow-bend test may be used as a substitute for, or as a useful addition to, the impact test. The effect of the shape notch on the impact and on the slow-bend values was also studied. The slow-bend test gives lower values than the impact for nonferrous alloys and higher than the impact for steels. The slow-bend method gives results which are, in general, similar to the impact-test results, but it is less responsive to the variations in the notched-bar properties. The slow-bend test gives some values which are related to the tensile strength. It is, however, less convenient for the ordinary routine practice than the impact test.

The notched-bar test and, particularly, the notched-bar impact test is very sensitive in showing up the directional differences in the properties of rolled metals caused by their fibrous structure and may be more conveniently used for this purpose than other tests. This refers to the specimens cut in the direction of rolling. (June 27, 1925.) 32 pp. Price, 20 cents.

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CIRCULARS

[All Circulars are subject to revision to keep the subject matter current. Inserted in this list of publications is a supplement giving the latest data concerning the latest editions of the Circulars. For example, the supplement gives for each Circular the Circular number, the latest edition number, date, number of pages, and price. The supplement also gives any modification required in the descriptive abstract for revised editions of Circulars. For publications in following list that are out of print, see the supplement to this Circular.]

C1. (Now in preparation. Will cover the organization, functions, and work of the Bureau.)

C2. Measurements of Length and Area, Including Thermal Expansion.

Gives the regulations under which length and area measuring apparatus, such as engineers' tapes, yard and meter standards, end standards, machine-shop gages, precision screws, and calipers are tested by the Bureau, shipping directions, schedule of fees, etc. The fundamental standards of length are described, the inter-relationship of the various units of length is given, and the methods of comparisons of length standards are outlined.

C3. Design and Test of Standards of Mass.

Contains general information on the fundamental standards of mass; a classification of weights into groups according to use (industrial or scientific); tolerances, and specifications for the construction of weights in each class; a discussion of the several methods of testing and adjusting weights; tables and formulas for correction of weighings for the buoyancy of the air, etc. The regulations governing the testing of weights by the Bureau of Standards and a schedule of fees for such testing are included.

C4. Verification of Standards of Capacity.

Gives shipping directions and a schedule of fees for metal capacity measures tested by the Bureau of Standards.

C5. Testing of Clinical Thermometers.

The edition of July 16, 1917, is considerably revised to announce new regulations, effective July 1, 1917, governing the certification of clinical thermometers. Past practice was to issue certificate in the form of a table of corrections at four points, 96°, 100°, 104°, and 108° F; the new certificate will be issued only for thermometers correct within 0.1° F at normal and 0.2° F at 104 and will contain the statement that the thermometer is correct within these tolerances.

The Circular contains a full description of the method of testing clinical thermometers and considerable matter of general interest concerning these instruments.

C6. Fees for Electric, Magnetic, and Photometric Testing.

States the kinds of tests performed and gives the fees established by the Bureau for tests of electric, magnetic, and photometric standards, measuring instruments, and materials. It supersedes the schedules of fees given in older editions of the various circulars upon these subjects, editions of which have been published since 1913 without the lists of fees. The fundamental units used as the basis of measurement are summarized. Specific instructions are given as to arranging for tests and shipping apparatus.

C7. Pyrometer Testing and Heat Measurements.

Information is given concerning the high-temperature scale, including a list of melting and boiling points suitable for calibration of pyrometers. Descriptions, precautions in use, and the methods of calibration of the various types of pyrometers are given, including thermoelectric, electrical resistance, optical, and radiation instruments. There is also given a list of the tests in heat measurements that the Bureau is equipped to carry out.

C8. Testing of Thermometers.

This Circular contains general information of interest to those who desire to submit thermometers to the bureau for test. Brief sections are devoted to the following topics: The standard scale of temperature; types of thermometers accepted for routine and special tests; number and choice of test points; test requirements and tolerances; certificates and reports for laboratory thermometers; reasons for refusal to test or to certify; notes on the breakage of thermometers; general instructions to applicants for tests; behavior of thermometers; schedules of fees.

C9. Testing of Glass Volumetric Apparatus.

Contains standard specifications for glass volumetric apparatus, describes the methods of test employed at the Bureau, and gives directions for submitting apparatus for test. The Circular also includes a schedule of fees for testing volumetric apparatus.

C10. Legal Weights (in pounds) per Bushel of Various Commodities.

Shows the legal weights per bushel of various commodities, as fixed by national legislation mainly for customs purposes and by the State legislatures for purposes of commerce within the States.

C11. Standardization of Bomb Calorimeters.

Primarily intended to accompany the standard heat samples which are sold by the Bureau. It contains a brief discussion of some of the principles underlying the construction and use of bomb calorimeters, also information as to the manipulation of such calorimeters and the computation of results. The schedule of fees for standard heat samples and for the testing of bomb calorimeters is included.

C12. Verification of Polariscopic Apparatus.

This Circular gives list of polariscopic tests, schedule and fees, and regulations concerning testing of polariscopic apparatus. [Superseded by C44.]

C13. Standard Specifications for Incandescent Electric Lamps.

These are the specifications under which tungsten and carbon filament incandescent electric lamps are purchased by the Federal Government. They describe in detail (1) the requirements as to the mechanical and physical characteristics of lamps, (2) the method of initial inspection and the selection of representative samples, and (3) the conditions under which these samples are tested for life at specified efficiencies. Although prepared primarily for use of the Government departments, these specifications are recognized as standard by the manufacturers and are used in contracts by many other purchasers of lamps. Only those thoroughly instructed in the art of lamp manufacture and in the science of photometry should undertake to determine the acceptability of lamps under the terms specified.

C14. Analyzed Irons and Steels—Methods of Analysis.

Outlines methods used by chemists of the Bureau for determining C in steels and irons (direct combustion method), Si, Ti (in irons), P, S, Mn, Cu, Mo (small amounts), Ni, Cr, V, and W.

C15. The International Unit of Light.

As a result of comparisons between the unit of light maintained at the Bureau of Standards, Washington; at the Laboratoire Central d'Électricité, Paris; at the National Physical Laboratory, London; and at the Physikalish-Technische Reichsanstalt, Berlin, an agreement was reached whereby a common unit, to be called the international candle, was adopted by the first three laboratories mentioned, and the simple ratio of nine-

tenths was adopted for the ratio of the German Hefner unit to the international candle.

This Circular contains the announcement which was made simultaneously in America, France, and England relative to the new unit. It contains also statements concerning (1) the different standards in use by the gas and the electrical industries; (2) the indorsement which various engineering bodies in this country and England gave to the movement for a common unit; and (3) the accuracy with which the light unit is maintained by means of incandescent electric lamps.

C16. The Testing of Hydrometers.

Contains standard specifications for hydrometers, the basis of certain arbitrary scales, and the methods employed at the Bureau in the testing of hydrometers. The Circular also includes directions for submitting apparatus for test and a schedule of fees for the testing of hydrometers.

C17. Magnetic Testing.

Deals with the fundamental magnetic quantities, with empirical formulas giving the relations between these quantities, with typical data of magnetic materials, and with the methods of magnetic measurements employed at the Bureau of Standards.

C18. Standard Gage for Sheet and Plate Iron and Steel.

A statement of the law establishing this standard; giving the thicknesses and weights per unit area corresponding to the various gage sizes.

C19. Standard Density and Volumetric Tables.

Contains standard density tables and others of a similar nature most often required in physical and chemical laboratories. For example, the density of water at all temperatures from 0° to 102° C; the density of various percentages of ethyl alcohol at various temperatures; temperature corrections to the indications of hydrometers in alcohol, sugar, and sulphuric-acid solutions; tables showing the relation between specific gravity and degrees Baumé for both heavy and light liquids; tables for determining the capacities of glass vessels from the weight of water contained or delivered; master scales for the graduation of hydrometers to indicate percentages of ethyl alcohol by weight or by volume or percentages of proof spirit.

C20. Electrical Measuring Instruments.

The object of this Circular is to present briefly the fundamental principles involved in the construction and operation of commercial electrical measuring instruments, together with such information concerning the advantages and limitations of the various types of instrument as will assist the user in the determination of the general type best suited to a given purpose. The question of sources of error has been treated in some detail, with a threefold purpose—first, to suggest how some errors can be avoided; second, how corrections may be made for known sources of error; third, to furnish suggestions which will assist those who have to specify instrument performance or to select instruments.

Some space has been given to a discussion of apparatus for use in the precision testing of electrical instruments in the laboratories of central stations, public-service commissions, and colleges. Some important points in regard to the design of electrical instruments are briefly discussed.

C21. Precision Measurements of Resistance and Electromotive Force.

Contains information concerning measurements and standards of resistance and electromotive force. The tests made by the Bureau of Standards of resistance standards, resistance apparatus, standard cells, and the electrical properties of conductors are described, and the specifications which such apparatus and material must meet in order to be accepted for test are included. General instructions are given for those who wish to submit apparatus or material to the Bureau of Standards for any of the tests described.

In the testing, information has been collected concerning the behavior of resistance apparatus, and some of this, which may be of interest to the users or intending purchasers of such apparatus, is given.

C22. Standard Specifications for Transformers, Oil-Immersed, Self-Cooled, 60-Cycle, 2200 Volts.

These specifications provide a standard for the purchase of transformers of the type most frequently used by Government departments and by other purchasers. They have been drawn with the cooperation of Government engineers and of representatives of leading manufacturers, with the purpose of securing the most serviceable apparatus on the market, and at the same time to admit the regular product of leading manufacturers.

C23. Standardization of Electrical Practice in Mines.

A committee was appointed by the American Mining Congress in 1909 to investigate the electrical practice in mines and to make recommendations for standardizing it. The Bureau of Standards was represented on this committee, and undertook a study of electrical mining laws and practice in conjunction with the committee. This Circular contains the preliminary report of the committee and the results of the Bureau's study. Proposed rules for the installation and use of electricity in mines are given together with explanatory statements and suggestions for avoiding the particular dangers due to the electric wires in mines. About half of the circular is devoted to the electrical mining laws in effect in the several States and foreign countries.

This Circular has not been revised because this work, undertaken before the Bureau of Mines was established, has since been taken over by that bureau. Inquiries for further information of this character should be addressed to the Bureau of Mines, Washington, D. C.

C24. Publications of the Bureau of Standards.

Gives titles of all five series—scientific papers, technologic papers, circulars, handbooks, and miscellaneous publications. The list is numerically arranged in each series and each title is accompanied by a descriptive abstract. An index facilitates reference to publications on specific subjects.

C25. Standard Samples—General Information.

Describes the functions and methods of preparing standard samples for use in analysis and gives summarized tables of analyses of the samples now being issued, together with prices and directions for ordering.

A supplement (separately printed inserted in each copy of the Circular) gives material subject to change, namely, summarized tables of analyses of the samples being issued, samples in preparation, a schedule of weights and fees, and directions for ordering.

C26. Analyzed Iron and Manganese Ores—Methods of Analysis.

The essential details of the methods employed at the Bureau of Standards in the analysis of the standard analyzed samples of iron and manganese ores are described and a brief statement of the methods used by the other analysts cooperating in this work is given. The following determinations are considered, viz, SiO_2, P, S, Al_2O_3, Ti, V, Fe (total and ferrous), available O, Mn, CaO, MgO, Na_2O, K_2O, H_2O, and CO_2.

C27. The Testing and Properties of Optical Instruments.

The properties of optical instruments are discussed. The principal errors in uncorrected lenses are enumerated and the methods of correcting these errors are outlined. The testing of lenses and optical instruments is described, and the fees for optical tests, including refractive index, are stated.

C28. The Determination of the Optical Properties of Materials.

This Circular treats briefly: (1) The fundamental laws of the reflection, absorption, and transmission of light; (2) the fundamental data or visual sensibility; (3) the specifications of color; (4) the characteristics and the testing of absorption and diffusion screens, such as colored spectacle glasses, photographic "ray filters," signal glasses, white matt surfaces, etc.; and (5) refractometry. [Out of print. Not to be reprinted, but to be superseded by future publications.]

C29. Announcement of a Change in the Value of the International Volt.

The international volt was for many years defined in terms of the electromotive force of the Clark cell. It was found that the Weston cell was superior to the Clark as a standard, and at the London International Electrical Congress of 1908 the Weston normal cell was adopted to replace the Clark cell as the international standard, and a special international committee was authorized to determine the value to be assigned as the electromotive force of the Weston normal cell. Accordingly, a joint investigation was undertaken at this Bureau by representatives of the national laboratories of England, France, Germany, and the United States.

The number decided upon as the electromotive force of the Weston normal cell was 1.0183 international volts at 20° C. This value was announced as effective on January 1, 1911. The unit is maintained by intercomparisons of standard cells by the national laboratories.

[Superseded by C60 and will not be reprinted.]

C30. Lime: Its Properties and Uses.

A brief description of the manufacture and properties of lime, and a discussion of the suitability of different kinds of lime for the various building and chemical industries.

C31. Copper Wire Tables.

These tables are in terms of the international standard values for the resistivity, temperature coefficient, and density of copper, which were adopted in 1913 by the International Electrotechnical Commission and were based on experimental investigations made at this Bureau. A historical discussion of standard values is given.

It was found necessary, in preparing the tables, to give considerable attention to the subject of wire gages. A history of wire gages and an account of the trend of present practice is given, together with a detailed consideration of the American wire gage.

The tables are comprehensive. Besides numerous tables giving the relations of resistance, length, and mass for standard sizes, there are tables of standard resistivities and temperature coefficients, wire gages, cables, and aluminum wire. The tables are duplicated in English and metric units.

Certain auxiliary questions are treated in appendices. These include: (1) The expression of the various kinds of resistivity and units thereof; (2) calculation of the constant connecting the change of resistivity with the temperature from the known law of proportionality between temperature coefficient and conductivity; (3) data on the density of copper; (4) calculation of the resistance and mass of cables; (5) international standard of resistance for copper. This Circular is a very complete compendium. Persons who desire only a wire table for working purposes should apply for the Copper Wire Table Card, listed on page 151, under "Miscellaneous."

C32. Standards for Gas Service.

This Circular is intended as an impartial and, as nearly as may be, an accurate summary of the facts which must be considered in connection with regulations affecting quality of gas and gas service. It has been prepared with the cooperation of many engineers and inspectors. It is, therefore, believed to reflect the opinion of the industry as well as to give the findings and recommendations of the Bureau.

A form is proposed for a model city gas ordinance, and rules are suggested for adoption of State public-service commissions. The technical matters involved are fully discussed, and a summary is given of all regulations in force in cities larger than 25 000 and in all States.

C33. United States Government Specification for Portland Cement.

Gives in detail the Government specification for Portland cement and describes the standard methods of testing. Additional sections are devoted to methods of chemical analysis and to interpretation of results of tests. There are included, also, the auxiliary specifications for testing sieves and specific-gravity flasks.

C34. The Relation of the Horsepower to the Kilowatt.

Various values have been given for the number of watts in a horsepower. The uncertainty of this equivalent arises from the fact that the value of the horsepower was originally expressed in gravitational units. As ordinarily used, the magnitudes of such units as the pound force, the foot-pound, etc., vary from place to place because of the variation of gravity. James Watt defined the horsepower as 550 foot-pounds per second. Using the value of the acceleration of gravity at the place where the experiments upon which the definition was based were made, this equals 746 watts. This value has the authority of long usage, is a convenient round number, and is the value which was recommended by the British Association Committee on Units in 1873. Using this value of 746 watts, the variation from place to place of the number of local foot-pounds per second in a horsepower is shown in the circular by tables. The "continental horsepower," which is used on the continent of Europe, is equal to 736 watts. It is thus over 1 per cent different from the horsepower used in the United States and Great Britain. Modern practice tends more and more toward the universal use of the kilowatt and the disuse of the horsepower. This practice is recommended by the Bureau.

C35. Melting Points of Chemical Elements, and Other Standard Temperatures.

Contains a complete list of the melting points in centigrade and Fahrenheit degrees of all the chemical elements and the boiling points of materials used as thermometric standards, as determined at the Bureau and elsewhere.

C36. The Testing and Properties of Electric Condensers.

In this circular the properties of the various types of condensers are discussed and tests are indicated by which the important properties of a condenser may be determined. Especial attention is given to mica condensers, but in addition air, paper, compressed gas, oil, and glass condensers are considered. The important constants of representative condensers of each class are given, and the characteristics of a good condenser of each type are stated.

C37. Electric Wire and Cable Terminology.

The Bureau, in cooperation with the Standards Committee of the American Institute of Electrical Engineers, investigated the confused terminology of electric wires and cables in 1912. Numerous persons and companies submitted their ideas and practices, and from them a standard set of definitions was evolved. These definitions are now accepted as standard in the industry. The circular gives standard definitions of "strand," "cable," and fifteen other principal terms. Each definition is accompanied by explanatory remarks, and in most cases is illustrated with a picture of the kind of conductor defined. The technical definitions of the terms are not far from the original common meanings of the words. A discussion of stranded conductors is included, giving the standard stranding for conductors of stock sizes.

C38. The Testing of Rubber Goods.

Gives the methods in use at the Bureau of Standards in the testing of rubber goods. The various physical tests commonly employed are described in detail, and the machines used for this purpose, many of which were designed at the Bureau, are illustrated and described in detail. Data are given showing the effect of various factors on the tensile properties of rubber. Special attention is given to the effect of temperature on the physical tests. The circular also contains a brief outline of the methods of collecting crude rubber and the processes used in the manufacture of various rubber articles.

The methods used in the chemical analysis are given, together with an explanation of the reasons for making these tests and their significance.

The methods of analysis and specification of the Joint Rubber Insulation Committee for 30 per cent Hevea insulation are given.

Regulations are given concerning the conditions under which tests are made for State and municipal governments and private parties.

C39. Specifications for and Measurement of Standard Sieves.

Discusses the methods of weaving the cloth used in such sieves, especially as they affect the question of tolerances to be allowed. Methods of use of the sieves, particularly in fineness tests of cement, are also given.

The specifications for standard sieves of 100, 200, 20, and 30 meshes per linear inch prepared by this Bureau and adopted by the Departmental Conference on Portland Cement Specifications are given. Methods of test and the forms of certificates and reports which this Bureau will issue are described, together with general instructions to applicants for tests. Later revised specifications for the 200-mesh sieve will be found in Technologic Paper No. 42.

[Superseded by new specification which may be obtained from the Bureau.]

C40. Sodium Oxalate as a Standard in Volumetric Analysis.

The considerations leading to the choice of sodium oxalate as a primary standard, especially for oxidimetry, are discussed. The methods for the purification and testing of sodium oxalate are described and its stability and hygroscopic properties are considered. Methods for using sodium oxalate as an oxidimetric and acidimetric standard are described, together with a consideration of the accuracy thereby attainable.

C41. Testing and Properties of Textile Materials.

Gives an outline of the procedure used at the Bureau of Standards for determining the identity, average length, percentage of moisture, percentage of oil, and other foreign matter of unspun fiber; the length, tensile strength and elongation, yarn number, twist, percentages of loading, sizing, and coloring material, and fiber composition of yarn, thread, and twine; and the weight, tensile strength and elongation, fiber composition, number of threads per inch, yarn number, folding endurance, and fastness of color of fabrics.

There are also given instructions regarding applications for test and shipment of samples and a schedule of the usual fees payable for tests.

C42. Metallographic Testing.

The following subjects are discussed: (1) Scope of the science of metallography; (2) thermal analysis; (3) microscopic analysis; (4) chemical and mechanical testing of metals as auxiliaries to metallographic examination.

Metals are tested to determine their structure, including homogenity; previous history, including heat and mechanical treatments; suitability for specific uses and in fulfillment of specifications, and for the determination of causes of failure. The apparatus and methods used by the Bureau in metallographic testing are briefly described.

C43. Jewelers' and Silversmiths' Weights and Measures.

Special conversion tables for jewelers and silversmiths, covering especially the gaging and weighing of precious metals. Outline of the metric system. The new metric carat. Gages of wires and drills. Gaging of watch glasses and the sizes of watches. Status of ring gaging. Miscellaneous tables, including decimal equivalents of gold karats, densities, melting points, temperature conversions, and approximate temperatures by color.

C44. Polarimetry.

Gives the basic principles of modern polarimetry, including a résumé of the work done at this Bureau and elsewhere in this field. Detailed descriptions of the more common types of polariscopes, saccharimeters, and apparatus are given, together with methods of use, testing, etc. Considerable space is devoted to methods of sugar analysis, together

with numerous tables. The preparation and testing of pure sucrose and dextrose is discussed. The United States Treasury Department sugar regulations are given. The results of recent researches are fully discussed, including the basis of standardization of the modern saccharimeter. The circular is of particular interest to the scientific investigator as well as persons engaged in the sugar industries.

C45. The Testing of Materials.

Describes the Bureau's work of testing structural and miscellaneous materials. A section is devoted to each principal class of materials, describing the sources, properties, uses, and methods of tests. The introduction treats of the theory of the testing of materials as leading to the development of standards of quality; regulations governing testing and fees are also given.

C46. The Testing of Barometers.

This circular, which is equally concerned with aneroid and mercurial barometers, is written for the guidance of persons who are already familiar with the normal operation of such instruments and desire them standardized at the Bureau. A brief enumeration of the defects and errors to be guarded against is followed by a schedule of fees for the various tests.

C47. Units of Weight and Measure—Definitions and Tables of Equivalents.

Supersedes the previous publication "Tables of Equivalents of United States Customary and Metric Weights and Measures" and in its new form includes definitions of the various units, with recognized multiples and subdivisions, the spelling and abbreviations adopted by the Bureau, as well as tables of equivalents from 1 to 999 units of the units of length, area, volume, capacity, and mass in the customary and metric systems.

C48. Standard Methods of Gas Testing.

Contains suggestions as to the location and equipment of gas-testing laboratories, a description of some of the accepted forms of apparatus, directions for the making of the various tests, and recommendations as to the interpretation of experimental results. It applies to work to be done in the official inspection of gas quality and gas service, especially that relating to heating value, candlepower, purity, and specific gravity of the gas and the pressure at which it is supplied.

C49. Safety Rules to be Observed in the Operation of Electrical Equipment and Lines.

A set of suggested rules to govern employers of workmen engaged in work on or about electrical equipment or lines and to govern the employees in their work. The two sections addressed to employers deal with requirements resting upon the operating organization, choice of employees, training, and like questions, including the provision of means by which employees can comply with the rules addressed directly to them.

The rules for employees comprise general precautions, the division of responsibility, specific rules for handling live parts, and procedures for the protection of employees working near live and moving parts.

Under special sections are included rules addressed to various classes of electrical workmen, including operators in stations, on lines overhead and underground, arc-lamp inspectors or trimmers, testing-room employees, meter workers, signal-line employees, and workers in tunnels or subways.

The purpose of the rules is to place before employers and employees alike, in convenient form, rules which have been found to promote safety in the operation of electrical equipment and lines. [Superseded by H3 and H4.]

C50. National Standard Hose Couplings and Fittings for Public Fire Service.

The Boston fire of 1872 and the Baltimore fire of 1904 emphasized the dangers of nonuniformity in fire-hose couplings. In spite of much agitation of the subject, little was done toward introducing an adopted standard until 1904. This circular gives the history of the movement, which culminated in the adoption of the national standard specifications by some dozen organizations. Couplings made according to these specifications have been put into service in 897 cities and towns. The specifications for the standard coupling are given and the method to be followed during transition from old to national standard.

C51. Measurement of Time and Tests of Timepieces.

Gives the regulations under which tests of timepieces are carried out at the Bureau of Standards, particularly tests of high-grade adjusted watches. The methods of test are described, and suggestions are given on the use and care of a watch. The sources of reliable standard time for the comparison of a watch are enumerated, and a table of the points of change of time in going from one standard-time section to another in the United States is given. The circular also gives the necessary directions for the submission of watches for test and a schedule of the fees charged.

C52. Regulation of Electrotyping Solutions.

This circular has been entirely rewritten and enlarged. The technical matter relates principally to the operation of copper electrotyping baths. The definitions of electrical terms and tables of equivalents and useful electrochemical data are of interest to electroplaters as well as electrotypers.

C53. The Composition, Properties, and Testing of Printing Inks.

A circular of general information on the subject of printing inks. The composition of some of the more common types of ink is given, together with a brief description of the constituents which are usually present. The processes in use for the manufacture of printing inks are described, the requisites for a good ink are discussed, and tests are given for determining the quality of an ink.

The circular also includes an abstract of the procedure for the analysis of printing inks already published by the Bureau.

C54. National Electrical Safety Code. [Superseded by H3 and H4.]

A code of rules for electrical construction and operation, to safeguard electrical practice. The code is divided into four parts. Part 1, on electrical supply stations, requires safe surroundings for station equipment, the proper isolation or guarding of live parts, according to voltage and use, the suitable grounding of machine frames, and the provision of adequate working spaces. Part 2, on electrical line construction, requires certain specified clearances and separations for supply and signal lines and certain strength, according to climatic conditions, to preserve these clearances. For underground lines the necessary spacing and accessibility are required. Part 3, on electrical utilization equipment, contains accident-prevention requirements for the electrical wiring and equipment of factories and homes. Part 4, on electrical operation, includes operating safety rules addressed to employers and employees concerned in electrical work. A supplementary section gives rules for grounding equipment and lines. Each part is accompanied by an explanatory discussion of its requirements. All the interested national electrical associations, commissions, and many other organizations have cooperated in its preparation and criticism, and the code may fairly be stated to be the most complete and satisfactory electrical safety code yet prepared. It will be revised from time to time by the Bureau to keep it abreast of practice.

C55. Measurements for the Household.

The purpose of this circular is (1) to give information as to units, methods, and instruments of measurement useful in household activities, (2) to describe available means of assuring correct quantity in articles bought by weight and measure, and (3) to give other facts of interest which would awaken an appreciation of the rôle of measurement in daily life.

This circular gives general information concerning the various kinds of measurement involved in household activities, such as measurement of purchases, measurements of heat, light, electricity, water, gas, humidity, density, pressure, and time. Emphasis is laid upon the practical application of this information. The broader aspect of measurement is considered as related to efficiency in household management. While trade weights and measures is an important part of the circular, in view of the growing interest in domestic science the other sections will prove of particular interest and value.

C56. Standards for Electric Service.

The factors determining the adequacy and safety of electric service are discussed in connection with the regulation of such service by State public-service commissions. Regulatory rules for State adoption and ordinances for cities are proposed. All electric-service rules now enforced by public-service commissions and municipalities are collected and compared, and a specification for the approval of types of electricity meters is proposed for adoption by such commissions.

C57. United States Standard Tables for Petroleum Oils.

Consists of tables for the use of those engaged in the oil industry. Tables 1, 2, and 3 give the specific gravity, degrees Baumé, and the volume of oil at 60° F from the values of these quantities observed at other temperatures. Tables 4 and 5 give the relations between specific gravity, degrees Baumé, and pounds per gallon.

C58. Invar and Related Nickel Steels.

This circular is mainly a composition from many sources of the properties of nickel steels, with particular reference to the properties of invar. There are chapters on magnetic, electrical, thermal, and mechanical properties, applications, sources, with brief statements on microstructure and constitution.

C59. United States Standard Baumé Hydrometer Scales.

Gives the origin, history, and present status of the Baumé scales in use in the United States, with special reference to the Baumé scale for petroleum oils. It is intended to counteract the misleading statements recently published outside the Bureau in regard to the Baumé scale.

C60. Electric Units and Standards.

A unified treatment is given of the principal units and standards in electricity and magnetism, the available information on which has hitherto been scattered over an extensive literature. This circular takes the place of various previous publications of the Bureau dealing with fragments of the subject. The circular includes a historical treatment, a classification of the units and systems of units, a discussion of the status of the magnetic units, a description of the fundamental electrical standards, the laws on electric units, conversion factors, and a bibliography.

C61. Specifications and Tolerances for Weights and Measures and Weighing and Measuring Devices.

These specifications and tolerances for weights and measures and weighing and measuring devices are designed to eliminate weights and measures which are false, without prejudice to such as conform as closely as is mechanically possible to the standards, and those which are of such construction that they are faulty, are not reasonably permanent in their indication or adjustment, or are designed to or may be used to facilitate the

perpetration of fraud. They were first adopted in 1913, and from time to time additions and amendments have been made until the present edition includes proper requirements for nearly all kinds of devices found in commercial use.

The classes of apparatus treated are linear measures; capacity measures, including glass graduates; measuring pumps; scales of all types; and weights.

C62. Specifications for and Methods of Testing Soaps.

A brief description of the general nature of soap is followed by recommended specifications for several commonly used varieties. The specifications contain methods of sampling and testing, which are made a part of each specification.

C63. Specification and Tests for the Transparency of Paper and Tracing Cloth.

Comprises an elementary explanation of the method used at the Bureau, a detailed description of the apparatus and experimental methods, a discussion of accuracy, a standard formula for the specification, some general information relative to transparency of tracing cloth, routine instructions to applicants for tests, and a schedule of tests and fees.

C64. Rules and Regulations for Enforcement of Lime-Barrel Act.

The rules and regulations contained in this circular are those which are authorized by section 4 of the act to standardize lime barrels (Public No. 228, 64th Congress), which reads as follows: "Sec. 4. That rules and regulations for the enforcement of this act, not inconsistent with the provisions of the act, shall be made by the Director of the Bureau of Standards and approved by the Secretary of Commerce, and that such rules and regulations shall include reasonable variations or tolerances which may be allowed." The text of the act is included as an appendix.

C65. Gas Calorimeter Tables.

A condensed set of operating and computing instructions for use with a flow gas calorimeter and tables of correction data.

C66. Standard Samples for Thermometric Fixed Points.

Description of methods of preparation, analysis, and determination of melting points of tin, zinc, aluminum, and copper to be issued by the Bureau as standard samples for reproducing certain fixed points of the temperature scale.

C67. Combined Table of Sizes in the Principal Wire Gages.

A table combining in one series the sizes in the American (B. & S.), Steel, Birmingham (Stubs'), British Standard, and Metric Wire Gages, arranged in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems in mils, inches, and millimeters, also the cross sections in square mils, circular mils, square inches, and square millimeters. The table is specially useful to manufacturers who wish to determine the nearest equivalent in American or British gage sizes of wires specified in millimeters or square millimeters, or vice versa.

C68. Public Utility Service Standards of Quality and Safety.

A brief outline of the public service activities of the Bureau together with lists of the publications bearing on the various subjects which are issued by the Bureau. The subheadings giving the public service activities are: Standards for Electric Service, Standards for Gas Service, Standard Methods of Gas Testing, National Electrical Safety Code, Electrolysis Mitigation, and Further Activities.

C69. Paint and Varnish.

This publication is intended to give, without unnecessary detail, information which should be of value to those interested in the use of paint and varnish. After a general discussion and classification of paints and varnishes and an explanation of the process of "drying" the raw materials, including oils, driers, thinners, resins, and pigments that enter into the composition of paint or varnish, are individually described. The methods of manufacture and of testing varnishes are presented, ready-mixed or prepared paints are discussed, and somewhat detailed instructions on mixing paints and stains, on color blending, and on the application of paint and varnish to various surfaces are given. Specifications in common use for many of the materials treated, and a glossary of painters' terms also appear.

C70. Materials for the Household.

Describes the more common materials used by the household, comprising paint materials, cement, clay products, lime, plasters and stucco, wood, metals, bituminous roofing, inks and dyes, adhesives, paper, textiles, rubber, leather, cleansers and preservatives, fuels, illuminants, lubricants, and a concluding chapter on quantity in the purchasing of materials. Each title is treated under the general heads of composition and definition, sources, properties, uses, tests, preservation, hints as to selection and use, and references.

C71. Rules and Regulations Promulgated Under Authority of the Federal Standard Barrel Law.

Section 3 of the Federal standard barrel law (38 Stat., ch. 158, p. 1186 63d Cong., 3d sess.) reads in part as follows:

"Sec. 3. That reasonable variations shall be permitted and tolerance shall be established by rules and regulations made by the Director of the Bureau of Standards and approved by the Secretary of Commerce * * *."

This Circular contains the rules and regulations which are authorized by the quoted part of the above law. The text of the law is included as an appendix to the publication.

C72. The Scope and Application of the National Electrical Safety Code.

This Circular is intended to aid those to whose attention the safety code has been called and those who are contemplating its adoption or use in acquiring the necessary familiarity with its intent and scope. The need for the code is explained and examples of personal injuries by electricity are given, most of them avoidable by observance of the rules. The method of arrangement of the code to promote its convenient use and the intended manner of application of the code by engineers and inspectors are briefly explained. A short summary is also given of the provisions of each of the four principal parts of the code.

As the code is being adopted on trial by many administrative bodies and public utility companies, it is expected that this circular will facilitate its introduction and aid in its interpretation.

C73. Copper.

This Circular deals primarily with the physical properties of pure and of commercial grades of copper. The best data and values are given for the various physical characteristics and constants, together with a bibliography of the sources from which these values are taken. The effect of impurities upon the properties of copper is discussed as well as the influence of various factors in its manufacture.

C74. Radio Instruments and Measurements.

This Circular is a treatise on radio measurements for use by Government officers, radio engineers, and others concerned. The Circular includes a development of the essential theory of high-frequency measurements from simple but precise low-frequency theory, the use of reactance curves in the rapid solution of problems, descriptions of radio instruments, and

formulas and data for radio work. The full treatment of fundamental principles will make this Circular serve as a foundation for later publications which may be issued by the Bureau on the general subject of radio communication.

C75. Safety for the Household.

Describes the seriousness of household hazards from fire, gas, electricity, and lightning, the nature of such hazards, and the precautions which should be taken to insure safety for the household. Illustrations are given to show the dangers of short-circuiting, of spontaneous combustion and other fire risks, and of gas accidents; and methods of safeguarding against lightning. Under the headings of fire and electricity a series of brief cautions are given.

C76. Aluminum and its Light Alloys.

The physical properties of aluminum and its light alloys are described and the effect of temperature, different manufacturing operations, and impurities upon these properties are discussed.

C77. The Table of Unit Displacement of Commodities.

This Circular, showing (1) the number of pounds of material per cubic foot as packed for shipment, (2) the number of cubic feet of space required for a short ton, (3) the number of cubic feet of space required for a long ton, and (4) the manner in which the it is packed, lists several hundred commercial commodities alphabetically. Appendixes give special information concerning automobiles, canned fruits and vegetables, and fresh fruits and vegetables.

This table has been prepared to meet an immediate demand for such information and will be revised and augmented from time to time as further data are obtained. The Bureau will, therefore, be pleased to receive information, criticisms, and suggestions from those interested in the table.

C78. Solders for Aluminum.

The use, serviceability, method of application, and composition of solders for aluminum are discussed in the light both of special tests made at the Bureau on commercial and other compositions of solders and of general experience with them. All soldered joints are subject to rapid corrosion and disintegration and are not recommended except where protection from corrosion is provided. Suitable compositions for solders are obtained by the use of tin with addition of zinc or both zinc and aluminum within wide percentage limits.

C79. Electrical Characteristics and Testing of Dry Cells.

This Circular summarizes the available information on dry cells. A brief description of the materials and methods of construction, and elementary theory of the operation of the cells is given. The various sizes and kinds of dry cells on the American market are described. The electrical characteristics of the cells and methods of testing them are discussed. In an appendix are given the proposed specifications for dry cells which have been prepared by the Bureau.

C80. Protective Metallic Coatings for the Rustproofing of Iron and Steel.

The various classes of protective metallic coatings (including oxide and similar coatings) are discussed as to production, structure, and methods of testing. In general, when protection rather than finish is desired, zinc should always be depended upon. The advantages of the various types of zinc coatings for particular purposes are pointed out. No general rule can be laid down for the testing of coatings; each type must be considered by itself. The salt-spray test, while being far from entirely satisfactory, approximates service conditions quite closely and is preferable to the other methods of testing which have been proposed and used.

C81. Bibliography of Scientific Literature Relating to Helium.

This publication contains a bibliography of the scientific literature relating to helium published up to January 1, 1919.

C82. Recommended Specification for Linseed Oil—Raw, Refined, and Boiled.

Prepared and recommended by the U. S. Interdepartmental Committee on Paint Specifications Standardization, April 16, 1919. This Committee was appointed at the suggestion of the Secretary of Commerce, and consisted of representatives of the War, Navy, Agriculture, Interior, Post Office, Treasury, and Commerce Departments, the Railroad Administration, the Panama Canal, and the War Service Committee of the Paint Manufacturers' Association of the United States. The Committee submitted a preliminary draft of this specification to more than 300 representatives of the paint and varnish industry, including all of the large manufacturers of linseed oil, and gave careful consideration to the large number of replies received in time. The specifications include the maximum and minimum for the various characteristics of raw linseed oil, refined linseed oil, and boiled linseed oil. The methods of sampling are prescribed and the test methods and reagents are described in detail. The basis of purchase may be either weight or volume, the unit being the pound or 100 pounds in one case or the gallon of 231 cubic inches (15.5°C) in the other.

C83. Specifications for the Manufacture and Installation of Railroad Track Scales.

This circular comprises specifications for the manufacture and installation of railroad track scales to establish a standard for the ordinary railroad freight-car weighing throughout the United States. They were prepared by a committee representing the American Railroad Association, the American Railway Engineering Association, the Railroad and Warehouse Commission of the State of Minnesota, the National Scale Men's Association, the Scale Manufacturer's Association, and the Bureau of Standards. These specifications will place in the hands of both railroads and private owners a definite and approved standard which will enable them to secure scales adequate to meet the modern weighing requirement, and it is hoped that a needed improvement in the weighing facilities will result.

C84. Recommended Specifications for Basic Carbonate White Lead, Dry and Paste.

These specifications, prepared under the auspices of the Bureau of Standards, are recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The topics include the laboratory examination of the dry pigment as to color, color strength, coarseness of particles, analysis, moisture, total lead and insoluble impurity, carbon dioxide; and the laboratory examination of the paste including caking in the container, mixing with linseed oil, moisture and volatile, pigment, fatty acid, test for mineral oil, iodine number, coarse particles, and skins. There are also given general statements concerning the dry pigment and paste, the method of sampling and description of the reagents used.

C85. Recommended Specification for Basic Sulphate White Lead, Dry and Paste.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. The topics include the general maximum and minimum specifications controlling the grain size and composition, also the methods of sampling, laboratory examination, and preparation of reagents.

C86. Recommended Specifications for Turpentine.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. The topics considered are the general maximum and minimum of the values of the significant properties, the appearance, color, and odor. The specification also includes the methods of sampling, laboratory examination, basis of purchase, and table of correction to barometer readings.

C87. Recommended Specifications for Zinc Oxide, Dry and Paste.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specifications cover the maxima and minima of the ingredients and grain size; also methods of sampling and laboratory examination and the methods of preparing the reagents.

C88. Recommended Specifications for Leaded Zinc Oxide, Dry and Paste.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specifications cover the maxima and minima of the ingredients and grain size; also methods of sampling and laboratory examination and the methods of preparing the reagents.

C89. Recommended Specifications for White Paint and Tinted Paints Made on a White Base, Semipaste and ready Mixed.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specifications cover the maxima and minima of the ingredients as in the case of the pigment, the semipaste, and ready-mixed paint, and the quality standards for the liquid in semipaste paint. The subjects treated include also the methods of sampling, laboratory examination, and preparation of reagents.

C90. Recommended Specifications for Red Lead, Dry and Paste.

These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization. These specifications give for the dry pigment or paste the maxima and minima and other quality standards, as well as the statement of methods of sampling and laboratory examination, and the preparation of the reagents.

C91. Recommended Specification for Ocher, Dry and Paste.

These specifications, prepared under the auspices of the Bureau of Standards, are recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the maximum and minimum of the various ingredients of the several constituents or impurities of the dry pigment and the maxima and minima of the pigment, linseed oil, moisture and volatile, and coarse particles and skins, for the paste. The methods of sampling are given, the laboratory test methods prescribed, and the methods of preparing the reagents are given.

C92. Operation and Care of Vehicle-Type Batteries.

The preparation of this circular was begun by the Construction Division of the Army using as a basis the results of tests made on tractor batteries at the Bureau of Standards. The circular contains a description of both the lead-acid and the nickel-iron types of batteries with the elementary theory of operation. Performance curves for both types are given, showing the characteristics of constant current and constant potential charging and for discharges at the normal five-hour rate and at five times this rate. Later sections of the circular discuss the subjects of capacity, voltage, resistance, methods of testing, methods of charging, and directions for repairing lead-acid batteries. Appendices A and B contain War Department specifications for batteries of this type and for charging equipment. Appendix C gives record forms to be used in maintenance, and appendix D outlines the method of computing costs of operation. Appendix E is a glossary of terms used in connection with storage batteries.

C93. Recommended Specification for Iron-Oxide and Iron-Hydroxide Paints.

This specification for iron-oxide and iron-hydroxide paints is one of a series of specifications for paint and paint materials. It was prepared under the auspices of the Bureau of Standards with the cooperation of an inter-

departmental committee organized for the purpose, and in cooperation with the Educational Bureau of the Paint Manufacturers' Association of the United States. Before final approval the specification was submitted to a large number of paint manufacturers, whose suggestions were carefully considered. The specification gives the required composition, methods of sampling, analytical methods for laboratory examination of both paste and ready-mixed paint, and describes acceptable methods of preparing the reagents to be used.

C94. Recommended Specification for Black Paint, Semipaste and Ready Mixed.

This specification was prepared under the auspices of the Bureau of Standards with the cooperation of an interdepartmental committee organized for the purpose, and in cooperation with the Educational Bureau of the Paint Manufacturers' Association of the United States. Before final approval the specification was submitted to a large number of paint manufacturers, whose suggestions were carefully considered. The specification gives the required composition, methods of sampling, analytical methods for laboratory examination of both paste and ready-mixed paint, and describes acceptable methods of preparing the reagents to be used.

C95. Inks—Their Composition, Manufacture, and Methods of Testing.

This is a circular of general information on the subject of inks. The composition and manufacture are discussed only briefly, but the methods of testing which are in use at the Bureau of Standards are given in sufficient detail to enable any chemist to use them. After a brief introduction on the history of ink, there are discussions of writing and copying inks, ink tablets and powders, marking, canceling, stamping, duplicating, and sympathetic inks. The methods used for the laboratory examination of all but the last of these kinds of ink are next taken up. Under the analysis of writing inks, for instance, are the following headings: Total solids, ash, iron, sulphuric anhydride, tannin, dye, chromium, penetration, fluidity, keeping quality, and resistance to light and reagents. For the other kinds of ink there is not such a variety of tests necessary. The circular closes with a short bibliography.

C96. Recommended Specifications for Quicklime and Hydrated Lime for Use in the Cooking of Rags for the Manufacture of Paper.

Lime shall contain not less than 95 per cent CaO. Hydrated lime shall contain not less than 72 per cent CaO.

C97. Recommended Specifications for Green Paint, Semipaste and Ready Mixed.

This specification for green paint—semipaste and ready mixed—refers to a chrome green paint, either in semipaste pigment ground in linseed oil, or ready mixed. The specification covers the general conditions and the maxima and minima of useful, harmful, or neutral constituents and methods of sampling, and the details as to the laboratory examination and analysis. The detailed methods of preparing the reagents to be used are also given. The standard was prepared under the auspices of the Bureau of Standards and submitted to large numbers of representative paint manufacturers, and also recommended by the United States Interdepartmental Committee on Paint Specification Standardization.

C98. Recommended Specifications for Volatile Mineral Spirits for Thinning Paints.

These specifications, prepared under the auspices of the Bureau of Standards, are recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the requirements regarding appearance, color, the spot test, flash point, sulphur, and reaction. The methods of sampling and laboratory examination are given; the basis of purchase is described in detail.

C99. The Carbonization of Lubricating Oils.

After brief accounts of the nature and effects of "carbon" deposits in internal combustion engines, and of the chemical nature of petroleum oils, the theories concerning the cause of these deposits are discussed. The oxidation and cracking of petroleum are next taken up in some detail after which the methods for determining the "Waters carbon" and the "Conradson carbon residue" are described. Other methods, including those depending on distillation, are touched upon. A brief summary of certain controversial papers closes the circular.

C100. Nickel.

This Circular is one of a series describing the physical properties of metals together with a discussion of the relation of these properties to the composition and treatment of the material. In this one are described the properties of nickel and of its commercially important alloys; nickel-steel, ferronickel, copper-nickel, and nickel-chromium alloys.

C101. Physical Properties of Materials: I. Strengths and related Properties of Metals and Certain Other Engineering Materials.

This circular aims to present in readily accessible form, the best available data on the strengths and related properties of metals, alloys, and certain nonferrous materials. Among the materials treated are iron, carbon steels, alloy steels; wire and wire rope; semisteel; aluminum, copper, and miscellaneous metals and their alloys; rope, rubber, leather, and woods.

The tensile strength, proportional limit, percentage elongation in two inches, percentage reduction of area, Brinell and scleroscope hardness corresponding to a certain composition, density, and method of preparation are shown in most cases for the metals and alloys.

In addition, figures are shown in many instances for the compressive and shearing strengths, modulus of rupture and Erichsen value.

The circular also includes definitions of the properties treated and references to sources.

C102. Recommended Specification for Composite Thinner for Thinning Semipaste Paints when the Use of Straight Linseed Oil is not Justified.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the requirements as to appearance, color, odor, mixing with linseed oil, drying, toughness, nonvolatile matter, and acid number. It describes the methods of sampling and of laboratory examination, and the method of preparing the reagents used.

C103. Recommended Specification for Spar Varnish.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the requirements as to appearance, color, flash point, nonvolatile matter, "set to touch," dry hardening and toughening, bending toughness, working properties, water resistance, and durability. The methods of sampling and laboratory examination are given in detail.

C104. Recommended Specification for Asphalt Varnish.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the requirements as to appearance; color; flash point; action with linseed oil; solubility in carbon bisulphide; nonvolatile matter; fatty matter; "set to touch;" dry hardening and toughening; bending toughness; working properties; and resistance to water, to oil, and to mineral acids. The methods of sampling and laboratory examination are given in detail.

C105. Recommended Specification for Liquid Paint Drier.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives a general statement regarding the composition, properties, and as to the requirements with respect to sediment, suspended matter, film, flash point, linseed oil mixing, and color. The methods of sampling and laboratory examination are given, as well as the basis of purchase.

C106. Lime—Definitions and Specifications.

General description of lime. Definition of trade terms. Recommended specification for masons' hydrated lime.

C107. The Testing of Paper.

Gives methods used at Bureau of Standards for determining the quality of paper, including the following tests: Weight, thickness, bursting strength, tensile strength, folding endurance, tearing strength, absorption, transparency, determination of loading and sizing material, and microscopical estimation of fiber content.

There is also given a general suggestion for specifications, a short bibliography, regulations regarding tests and suggestions for sampling.

C108. Gypsum—Properties, Definitions, and Uses.

Description of the general properties of gypsum products, definitions of trade terms and specifications.

C109. Sand-Lime Brick—Description and Specification.

General, nontechnical, description of sand-lime brick, with the specifications recommended by the Bureau.

C110. Specifications for Marine Sextants.

These specifications, incorporating standard practice in design and performance of sextants, are the basis for certificates issued by the Bureau of Standards. They cover the rigidity, durability, convenience of operation, and mechanical perfection of the instrument; range and accuracy of the scales; consistent tolerances for the mirrors, shade glasses, and telescopes; and provisions for adjustment and replacements.

New instruments are expected to conform closely with these specifications or represent improvements. The precision required of old instruments is placed somewhat below that required of new in order that those which are still serviceable and reliable may not be excluded from certification.

C111. Recommended Specification for Flat Interior Lithopone Paint, White and Light Tints.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification gives the requirements as to constituents, their maxima and minima, the methods of sampling and laboratory examination, including the analysis of the pigment and the preparation of the reagents.

C112. Telephone Service.

Service in general, service grades, service classification and service development are considered in an introductory section. The next four sections are descriptive of the telephone plant and its operation. These are followed by a section on telephone traffic which considers the handling of calls from a quantitative standpoint. The next section is of an analytical character and explains the relation of the elementary characteristics of telephone service to the grade of service. A section regarding public relations is included to cover commission regulation and a conclusion regarding the subject of service standards. A statistical section is appended.

C113. The Structure and Related Properties of Metals.

This Circular which replaces one of earlier date (No. 42, Metallographic Testing) is a comprehensive discussion of that phase of metallography indicated by the above title. The numerous examples which have been used throughout the test have been taken from the results of metallographic examinations made by the Bureau, of specimens submitted for examination as well as those used for research. The various methods for revealing the macrostructure as well as the meaning of the features revealed are discussed, and a list of reagents for revealing the microstructure included. By means of numerous "live" examples the conditions which affect the structure of metals are discussed, also the effect of structural features upon mechanical and chemical properties of metals. A rather comprehensive discussion of the applications of the microscopy of metals has been given.

C114. Standard Specifications for Cotton Rubber-Lined Fire Hose.

The frequent calls made upon the Bureau of Standards for fire-hose specifications have resulted in the formulation of the standard specifications in this Circular These specifications were prepared by the Bureau in cooperation with technical experts appointed as representatives of the leading manufacturers of fire hose. The specifications have been officially endorsed by the Rubber Association of America. The topics covered include both physical and chemical laboratory requirements, hydraulic pressure tests on full lengths of hose, and of essential characteristics of both lining and jacket. Provision is made for the basis of payment and the interpretation of specifications and action in case of disputes.

C115. Recommended Specifications for Pneumatic Tires, Solid Tires, and Inner Tubes.

These specifications cover the requirements for pueumatic tires, solid tires, and inner tubes. Recommended by the Interdepartmental Committee on Specification Standardization, June 8, 1921.

These specifications are a revision of those prepared by the Bureau and now used by the War Department, Navy Department, Panama Canal, and the Treasury Department.

A tentative draft of the specifications was submitted to a large number of representatives of the tire industry, including the Rubber Association of America, and in the revision careful consideration was given to their recommendations.

C116. How to Get Better Service with Less Natural Gas in Domestic Gas Appliances.

This circular gives the principal conclusions from the laboratory and field investigations of the Bureau, on the correct use of natural gas in the home. Proper adjustment of appliances will make it possible to get better service with much less gas, and it will allow the gas pressure to be reduced to two ounces or less. Reduction in pressure will greatly reduce the leakage in the distributing systems and this with the saving in the homes will add a large number of years to the period that natural gas will be available for domestic use.

C117. Recommended Specification for Interior Varnish.

This specification, prepared under the auspices of the Bureau of Standards, is recommended by the U. S. Interdepartmental Committee on Paint Specification Standardization. The specification describes the acceptable varnish with respect to ease of application and the resulting elastic glossy coating, also the general characteristics including appearance, color, flash point, nonvolatile, "set to touch," dry hardening, dryness for rubbing, toughness, working properties, and water resistance. The methods of sampling and laboratory examination are given and the basis of purchase prescribed.

C118. Recommended Specification for Limestone, Quicklime, and Hydrated Lime for Use in the Manufacture of Glass.

Requirements are given for three classes of lime, depending upon the quality of the glass to be made. Combined CaO and MgO is to be not less than 96, 91, and 83 per cent, respectively, for the three classes.

C119. Specifications for Lime Flint Glass Tumblers.

These specifications include dimensions for the article, with tolerances, a statement of quality required, tests for quality, basis of acceptance or rejection of order, and method of sampling. (These specifications have been accepted by the Army, Navy and Marine Corps, Panama Canal, Public Health Service, and General Supply Committee.)

C120. Construction and Operation of a Simple Home-Made Radio Receiving Outfit.

The construction of a very simple radio receiving equipment for radio communication on wave lengths between 600 and 200 m from high-power stations within 50 miles is described. This set may be easily constructed by anyone from materials which can be readily secured. The total cost of this equipment need not exceed $10. A single circuit, with a crystal detector and an inductor variable by steps, is used. Instructions are given for the construction of the crystal detector, inductor, necessary switches, antenna, and other parts. Certain parts, such as the telephone receivers, must be purchased. Directions for operation are also given.

C121. Construction and Operation of a Two-Circuit Radio Receiving Equipment with Crystal Detector.

The construction of a very simple radio receiving equipment is described which may be easily constructed by anyone from materials which are readily obtainable. The total cost of the equipment need not exceed $15. A double circuit, composed of primary and secondary inductors, which are variable by steps, and a crystal detector are used. Instructions are given for the construction of the inductors, switches, wood parts, and crystal detector. Reference is made to Bureau of Standards Circular No. 120, which describes the construction of the other necessary parts. Certain parts, such as the telephone receivers, must be purchased. Directions for operation are also given.

C122. Sources of Elementary Radio Information.

The recent developments in radio communication have been so rapid that much important radio information has not yet been collected in books, but must be sought in periodicals and other sources. A number of important books have appeared recently and are not generally known. The Bureau of Standards is constantly receiving requests for radio information. Many of the inquiries call for the same information, and in order to facilitate the handling of such inquiries this circular has been prepared. This circular gives information concerning radio periodicals, radio books issued by various publishers, Government radio publications issued by various bureaus, including the publications of the Bureau of Standards, radio laws and regulations and call letters, and answers a few of the most usual elementary questions concerning radio communication which are asked by the novice.

C123. United States Government Specification for White Floating Soap.

The material covered by this specification is a high-grade cake soap suitable for toilet use and for fine laundry work.

NOTE.—This specification is one of a series of specifications prepared to cover 10 different kinds of soap, each suitable for a particular purpose. The specifications were prepared under the auspices of the Bureau of Standards by a technical committee of the Federal Specifications Board in cooperation with the soap committee of the soap section of the American Specialty Manufacturers Association. The specifications, in general, cover the maximum and the minimum of the ingredients; also methods of sampling and laboratory examination, reparation of reagents, and basis of purchase.

C124. United States Government Specification for Liquid Soap.

The material covered by this specification is a clear solution of pure vegetable oil potash (or potash and soda) soap for toilet use in dispensing-machines. (See also note in abstract for C123 for further data.)

C125. United States Government Specification for Soap Powder.

The material covered by this specification is a uniform mixture of soap and sodium carbonate in powdered form. It is suitable for general household work owing to its ease of application, solubility, and cleansing quality. (See also note in abstract for C123 for further data.)

C126. United States Government Specification for Salt Water Soap.

The material covered by this specification is a coconut-oil soap suitable for use in both sea water and fresh water. (See also note in abstract for C123 for further data.)

C127. United States Government Specification for Automobile Soap.

The material covered by this specification is a pure vegetable-oil paste soap containing no free alkali or acid and suitable for use in washing automobiles. (See also note in abstract for C123 for further data.)

C128. United States Government Specifications for Chip Soap.

The material covered by this specification is a high-grade soap in chip form, free from rosin and impurities. It is suitable for high-grade laundry work with soft water. (See also note in abstract for C123 for further data.)

C129. United States Government Specification for Ordimary Laundry Soap.

The material covered by this specification is a well-made, uniformy mixed laundry or common soap. It is suitable for use with moderately hard water for general cleaning and laundry purposes. (See also note in abstract for C123 for further data.)

C130. United States Government Specification for Grit Cake Soap.

The material covered by this specification is a compact cake soap containing finely divided siliceous material. Two grades are specified: (*a*) For fine work, such as glass and enamel; (*b*) for scouring and scrubbing. (See also note in abstract for C123 for further data.)

C131. United States Government Specification for Scouring Compounds (*a*) and (*b*) for Floors, and Soap Scouring Compounds (*c*).

This specification covers three grades of powdered material composed of siliceous matter, sodium carbonate, and soap: (*a*) For fine marble floors, (*b*) for tile or ceramic and terrazzo floors, and (*c*) soap-scouring compound for general cleaning and scrubbing. (See also note in abstract for C123 for further data.)

C132. United States Government Specification for Hand Grit Soap.

The material covered by this specification is a high-grade cake soap containing about one-third its weight of clean, finely divided, insoluble siliceous matter. (See also note in abstract for C123 for further data.)

C133. Description and Operation of an Electron-Tube Detector Unit for Simple Radio Receiving Outfits.

The apparatus now used (1922) for radio reception, except the most simple types, uses electron tubes. The tube may be used as a simple detector, or may be used in more complicated circuits employing various kinds of amplification, or regeneration, heat reception, or other methods. A set employing an electron-tube detector is more sensitive than a set employing a crystal detector and may be expected to give more satisfactory results. This circular describes a simple electron-tube detector receiving set and gives a method of operating it. An antenna, lightning switch, ground connection, and telephone receivers, which can be used with this set, are described in Circular 120. Tuning devices for use with this electron-tube detector unit have been described in Circulars 120 and 121. A number of the parts of the detector unit should be purchased. A complete description of the method of assembling and wiring the detector unit is given. Illustrations are given showing the arrangement of the various parts and the complete assembled detector unit. Detailed instructions for operating the set are also given.

C134. United States Government Specification for Fire-Extinguishing Liquid (Carbon Tetrachloride Base).

This specification was prepared by a technical committee of the Federal Specifications Board. Before final approval it was submitted to the Underwriters' Laboratories and to a large number of manufacturers of such products, whose suggestions were carefully considered. The specification covers the general conditions, appearance, specific gravity, cold test, distillation test, impurities, sampling, and methods of testing.

C135. Caustic Magnesia Cement.

A brief summary of the discovery, early history, and later application of the reaction of caustic magnesia with solutions of magnesium chloride. The result of this reaction produces a quick hardening cement used in the stucco, flooring, and ship-decking trade. Short descriptions are given of the ore used, methods of calcining the ore, also suggested formulas for several types of products, the general qualities of these, and the lines along which specifications for the cement are being developed.

C136. Specification for Numbered Cotton Duck for Government and Commercial Use.

Specifications are given including weave, width, weight, count, ply, and breaking strength, also an expression as to what constitutes a good delivery. These specifications were drawn up by the Cotton Duck Association and the Bureau of Standards after extensive research, valuable assistance being given by other Government departments.

C137. Auxiliary Condensers and Loading Coil Used With Simple Homemade Radio Receiving Outfits.

This is the fourth circular in a series of descriptions of very simple radio receiving outfits which will receive radio telephone signals and also radio telegraph signals, except those transmitted by the use of uninterrupted continuous waves. In Circular No. 120 a single-circuit receiving set was described, and in Circular No. 121 a two-circuit set was described. The operation of either can be improved by the use of a very simple and cheap condenser connected across the telephone receivers and a similar one connected in series with the antenna. Longer waves can be received by the use of a very simple type of loading coil. The coil is particularly useful in connection with the single-circuit receiving set.

C138. A Decimal Classification of Radio Subjects—An Extension of the Dewey System.

This circular gives a decimal classification of radio subjects which was developed at the Bureau of Standards about two years ago. This classification is suggested as an extension of the Dewey decimal system and has been found to be very useful in classifying radio references, drawings, books, and reports. Radio communication is divided into a general class and a number of specific classes, each with appropriate subdivisions. An abbreviated classification is suggested for those readers who have only a small amount of material to classify. This may then be gradually extended as the needs of the user dictate. An index is also provided.

C139. United States Government Specification for Dry Cells.

This specification is a revision of that originally published in the first edition of Circular No. 79. Much additional experience has been gained in testing dry cells since the specification was first issued, and a revision was deemed desirable. The Bureau of Standards called a conference of representatives of manufacturers, Government departments, and a few of the largest individual users of dry cells and flashlight batteries, to consider the standardization of sizes and a revision of specifications for them. This conference met at the bureau on December 5 and 6, 1921. A limited number of the most important sizes were standardized and tests defined. The bureau was asked to complete the revision of the specification and to submit it to the members of the conference for criticism. This has been done. This specification includes the dimensions as agreed upon.

C140. United States Government Specification for Wood Screws.

This specification covers flat, round, and oval head types, together with the numbers, diameters, threads per inch, methods of measuring diameters and lengths, tolerances, and the standard sizes of brass and steel wood screws. The requirements of this specification are standard, and were drawn with the assistance and approval of the manufacturers.

C141. Description and Operation of an Audio-Frequency Amplifier Unit for Simple Radio Receiving Outfits.

This is the fifth circular in a series of descriptions of very simple radio receiving outfits. In Circular No. 133 an electron-tube detector unit to be used in conjunction with the single-circuit set (Circular No. 120) or with the two-circuit set (Circular No. 121) is described. This circular describes an audio-frequency amplifier unit, one or two of which may be used with the apparatus just mentioned, to increase the receiving radius of the station, as well as the volume of sound in the telephone receivers.

C142. Tables of Thermodynamic Properties of Ammonia.

These tables of the thermodynamic properties of saturated and superheated ammonia are based on measurements made at the Bureau of Standards. The tables have been put in convenient form for use in engineering practice, and the same data are given in graphic form as a Mollier chart. The range of temperature and pressure covered by the tables is greater than that usually encountered in the use of ammonia as a refrigerating medium.

C143. Recommended Specification for Quicklime for Use in Causticizing.

A brief description of the way in which lime is used in causticizing is followed by a general statement as to the quality of lime required. The standard of quality for lime for this purpose is set at 85 per cent available lime. Any shipment containing less than 70 per cent available lime or more than 3 per cent magnesia should be rejected as uneconomical to use. Complete directions for sampling, testing, and retesting are included.

C144. Recommended Specification for Limestone and Quicklime for Use in the Manufacture of Sulphite Pulp.

Limestone or quicklime is used to prepare the cooking liquor in which wood is cooked to reduce it to paper pulp. It is customary to use a high calcium limestone when preparing liquor by the tower process, or a high magnesian quicklime with the tank process, but other kinds of limestone or quicklime are being used. The specification, therefore, covers high calcium and high magnesian limestone and quicklime, on a basis of about 95 per cent purity.

C145. Summary of Technical Methods for the Utilization of Molasses, Collated from Patent Literature, for the Use of the American Sugar Industry.

Economic conditions the world over have made it generally recognized that the future of the American beet-sugar industry is to a great extent dependent on the profitable utilization of the molasses produced. The latter contains numerous valuable substances which have never been successfully recovered outside of Germany. For many years that country has seen fit to veil its developments and discoveries and to maintain the strictest secrecy regarding the operation of its molasses plants. The scientific literature on the subject is practically barren, so far as the actual results achieved in Germany are concerned. In order to carry out the necessary experimental work for the American industry, every possible source of information has been investigated. After a few clues were obtained, the U. S. Patent Office literature was searched and eventually over 1,000 German patents on molasses utilization and associated subjects were uncovered. The difficulty in locating these patents was due to the fact that they are not listed under sugar or molasses or subjects that were known to the bureau's investigators. The value of the information contained in many of these patents was so apparent and the necessity for knowledge of their contents was so obvious that the present résumé of the more important patents on the recovery of the nonsugars has been compiled.

C146. United States Government Specification for Water Resisting Red Enamel.

This specification was prepared by the technical committee on paints of the Federal Specifications Board after careful consideration of suggestions from manufacturers. The specification calls for an extremely durable, highest quality, red enamel, suitable primarily for outside use. Details as to general requirements, methods of sampling, and testing are included.

C147 United States Government Specification for Gloss Interior Lithopone Paint. White and Light Tints.

This specification was prepared by the technical committee on paints of the Federal Specifications Board, after carefully considering suggestions from paint manufacturers. This specification relates to paints not intended for outside exposure. They shall dry to gloss opaque coats that will adhere well to wood, metal, and plaster; stand washing with soap and water; and show no yellowing when kept in the dark. Detailed directions for sampling and testing are included.

C148. United States Government Specification for Leather Belting.

United States Government specifications for leather belting developed by the Bureau of Standards, subcommittee on leather products of the Federal Specifications Board, and a committee representing the manufacturers. Standard specification relative to the quality of the leather and construction of the belting is included. Physical and chemical requirements are provided, which serve as standards of quality, together with methods for making the tests.

C149 A Standardized Method of Measuring The Size of Hosiery

The publication contains a description with diagrams of a standard method of measuring the size of hosiery. It also compares the various methods described in questionnaires which were sent out. The standard is the first attempt to state definite requirements for measuring hosiery. This method is of great practical value to manufacturers and consumers.

C150. Recommended Specification for Quicklime and Hydrated Lime for Use in the Manufacture of Sand-Lime Brick

Sand-lime brick is made of sand bound together with lime. The lime is caused to combine chemically with some of the sand by treatment with high pressure steam. Lime for this purpose must be completely hydrated and must be reasonably free from magnesia and carbon dioxide. About 85 per cent purity is required.

C151. Wall Plaster: Its Ingredients, Preparation, and Properties

This is the report of the Bureau of Standards Plastering Conference. Every phase of wall plaster is described except the manufacture of the raw material. The functions, kinds, use, and defects of wall plaster are fully given. The results are based upon recommendations of manufacturers, users, independent interested parties, and the Bureau of Standards.

C152. Recommended Specification for Ceramic Whiting

Ceramic whiting is a finely divided form of calcium carbonate used as a flux in the manufacture of ceramics. It should be of about 97 per cent purity, and 98 per cent should pass a No. 200 screen.

C153. Recommended Specification for Quicklime and Hydrated Lime for the Manufacture of Silica Brick

A brief description of the way in which lime is used in the manufacture of silica brick is followed by a general statement as to the quality of lime required. The standard of quality is set at 92 per cent, based on the nonvolatile matter, with maximum limits of 5 and 10 per cent carbon dioxide, depending upon whether the sample is taken at point of shipment or of destination. Complete directions for sampling and testing are included.

C154. National Standard Petroleum Oil Tables

Contains tables made up for the use in the petroleum oil industry. Tables 1, 2, and 3 give the degrees A. P. I., the volume, and the specific gravity of oil at 60° F. from the values observed at other temperatures. Tables 4 and 5 give the relation between specific gravity, degrees A. P. I., pounds per gallon, and gallons per pound. Table 6 gives the degrees A. P. I. (modulus 141.5) corresponding to degrees Baumé (modulus 140).

C155. United States Government Master Specification for Coal-Tar Pitch for Waterproofing and Damp Proofing.

This material is intended for use alone as a damp-proof coating for concrete, masonry, etc., or as a plying cement with coal-tar saturated rag felt for roofing and waterproofing in the construction of membrane waterproofing. It is suitable for damp proofing and waterproofing tanks, retaining walls, dams, conduits, foundations of buildings, tunnels, subways, pools, reservoirs, etc., where not exposed except during installation to temperatures exceeding 100° F. and where not subject to vibration.

C156. United States Government Specification for Coal-Tar Saturated Rag Felt for Roofing and Waterproofing.

This material is composed of rag-roofing felt impregnated with coal-tar saturating materials. It is intended for use with coal-tar pitch for roofing (C157) in the construction of coal-tar built-up roofing; also with coal-tar pitch for waterproofing and damp proofing (C155) in the construction of membrane waterproofing.

C157. United States Government Master Specification for Coal-Tar Pitch for Roofing.

This specification covers coal-tar pitch produced from the straight distillation of gas-house or coke-oven coal tars or mixtures of them. It is intended for use as a plying cement with coal-tar saturated rag felt for roofing and waterproofing (C156) in the construction of 3, 4, and 5 ply built-up roofing surfaced with surfacing materials conforming to Circular 158. It is suitable for use on inclines not exceeding 3 inches to the foot in the case of roof surfaces, into which nails can be driven, and on inclines not exceeding 1 inch per foot in the case of concrete.

C158. United States Government Master Specification for Surfacing Materials for Bituminous Built-Up Roofing.

These specifications cover gravel, crushed slag, crushed stone, promenade tile, and slate slabs for use in surfacing built-up roofing constructed with asphalt and coal-tar pitch.

C159. United States Government Master Specification for Asphalt for Mineral-Surfaced Roofing.

This material may be either a petroleum asphalt or mixtures of refined Trinidad asphalt with suitable fluxing materials. It is intended for use as a plying cement with asphalt saturated-rag felt for roofing and waterproofing (C161), in the construction of 3, 4, and 5 ply built-up roofing surfaced with surfacing materials conforming to Circular 158. It is adapted to boards, concrete, or gypsum roof surfaces with inclines not exceeding 3 inches to the foot.

C160. United States Government Master Specification for Asphalt for Waterproofing and Damp Proofing.

This material is intended for use alone as a damp-proof coating for concrete, masonry, etc., or as a plying cement with asphalt saturated-rag felt for roofing and waterproofing (C161) in the construction of membrane waterproofing. It is suitable for damp proofing and waterproofing railroad bridges, tanks, retaining walls, dams, conduits, foundations of buildings, tunnels, subways, pools, reservoirs, etc.

C161. United States Government Specification for Asphalt-Saturated Rag Felt for Roofing and Waterproofing.

This material is composed of rag roofing felt impregnated with asphaltic saturating materials. It is intended for use with asphalt for mineral surfaced roofing (C159) and asphalt for unsurfaced built-up roofing (C168), in the construction of asphalt built-up roofing; also for use with asphalt for waterproofing and damp proofing (C160) in the construction of membrane waterproofing.

C162. United States Government Master Specification for Asphalt Primer for Roofing and Waterproofing.

This material consists of an asphaltic substance thinned to a suitable brushing consistency with a volatile solvent. It is intended for use as a bonding or priming coat for concrete and gypsum surfaces upon which hot asphalt is to be mopped in the application of asphalt roofing, waterproofing, and damp proofing.

C163. United States Government Specification for Titanium Pigment, Dry and Paste.

This specification was prepared by the technical committee on paints of the Federal Specifications Board after careful consideration of suggestions from manufacturers. The specification calls for a pigment composed of about one-fourth titanium oxide and three-fourths precipitated barium sulphate. Details as to requirements and methods of sampling and testing are included.

C164. United States Government Master Specification for Flat Glass for Glazing Purposes.

This circular provides a classification of the various types of flat glass used for glazing purposes and definitions and proper nomenclature are given. The specifications include grades, sizes, thicknesses, and detailed quality descriptions. A method of examination is presented to identify the quality of the glass. Patterns of figured glass are illustrated.

C165. United States Government Master Specification for Olive Drab Paint (Semipaste and Ready-Mixed).

This specification was prepared by the technical committee on paints of the Federal Specifications Board after carefully considering suggestions from paint manufacturers. The specification covers requirements for a high-grade olive drab oil paint for outside and general use. The pigment shall contain not less than 35 per cent of white lead and not less than 30 per cent of zinc oxide, with necessary tinting colors, but free from organic colors and sulphide sulphur. Details as to composition of semipaste and ready-mixed paint methods of sampling and testing are included.

C166. United States Government Master Specification for Light-Weight Duck (Army Duck), Grey.

This specification was prepared under the supervision of the textile section of the Bureau of Standards by the Cotton Duck Association and the technical committee on textiles of the Federal Specifications Board. The specification includes weave, thread count and ply, width, length of bolt or roll, weight, and breaking strength. The standard grab method, 1 by 1 by 3 inches, is specified.

C167. United States Government Master Specification for Tent Duck (Special Construction for Bleaching or Dyeing), Grey.

This specification was prepared under the supervision of the textile section of the Bureau of Standards by the Cotton Duck Association, and the technical committee on textiles of the Federal Specifications Board. The specification includes weave, thread count and ply, width, length of bolt or roll, weight, and breaking strength. The standard grab method, 1 by 1 by 3 inches, is specified.

C168. United States Government Master Specification for Asphalt for Unsurfaced Built-Up Roofing.

This material may be either a petroleum asphalt or mixtures of refined Trinidad asphalt with suitable fluxing materials. It is intended for use as a plying cement with either asphalt saturated rag felt or asphalt saturated asbestos felt in the construction of 3 and 4 ply unsurfaced built-up roofing. The specifications cover two grades of material: (1) For use on inclines not exceeding 3 inches to the foot over boards, and 1½ inches to the foot over concrete; (2) for use on inclines not exceeding 6 inches to the foot over boards, and 3 inches to the foot over concrete.

C169. Methods of Calculating Hosiery Shipping Case Dimensions.

Methods for calculating the most economical dimensions of hosiery shipping cases are given when either the proposed standard inside dimensions of the hosiery boxes or when other sizes of boxes are used. The development of the equation of a minimum surface of a hexahedron for a given volume is shown, and use is made of it in selecting the most economical case. Considerations involving the use of these boxes are given, listing, in addition, the most common sizes which might be used by a manufacturer of all styles of hosiery. The dimensions of the most suitable arrangements only are given. The feature is the saving resulting from reduction of the surface in the construction of the case.

C170. United States Government Master Specification for the Construction of Built-Up Roofing, Type 4AWS.

Roofing of type 4AWS consists of four layers of asphalt-saturated rag felt cemented together with asphalt and surfaced with proper surfacing materials. It is adapted to roof surfaces of board sheathing with inclines not exceeding 3 inches to the foot or precast gypsum slabs with inclines not exceeding 1 inch to the foot.

C171. United States Government Master Specification for the Construction of Built-Up Roofing, Type 5AWS.

Roofing of type 5AWS consists of five layers of asphalt-saturated rag felt cemented together with asphalt and surfaced with proper surfacing materials. It is suitable for roof surfaces of board sheathing with inclines not exceeding 3 inches to the foot or precast gypsum slabs or blocks with inclines not exceeding 1 inch to the foot.

C172. United States Government Master Specification for the Construction of Built-Up Roofing, Type 3ACS.

Roofing of type ACS consists of three layers of asphalt-saturated rag felt cemented together with asphalt and surfaced with suitable surfacing materials. It is adapted to concrete and poured gypsum roof surfaces with inclines not exceeding 3 inches to the foot.

C173. United States Government Master Specification for the Construction of Built-Up Roofing, Type 4ACS.

Roofing of type 4ACS consists of four layers of asphalt-saturated rag felt cemented together with asphalt and surfaced with suitable surfacing materials. It is adapted to concrete and poured gypsum roof surfaces with inclines not exceeding 3 inches to the foot.

C174. United States Government Master Specification for the Construction of Built-Up Roofing, Type 5ACS.

Roofing of type 5ACS consists of five layers of asphalt-saturated rag felt cemented together with asphalt and surfaced with suitable surfacing materials. It is adapted to concrete and poured gypsum roof surfaces with inclines not exceeding 3 inches to the foot.

C175. United States Government Master Specification for the Construction of Built-Up Roofing, Type 3TCS.

Roofing of type 3TCS consists of three layers of coal-tar-saturated rag felt cemented together with coal-tar pitch and surfaced with suitable surfacing materials. It is suitable for concrete and poured gypsum roof surfaces with inclines not exceeding 1 inch to the foot.

C176. United States Government Master Specification for the Construction of Built-Up Roofing, Type 4TCS.

Roofing of type 4TCS consists of four layers of coal-tar-saturated rag felt cemented together with coal-tar pitch and surfaced with suitable surfacing materials. It is suitable for concrete and poured gypsum roof surfaces with inclines not exceeding 1 inch to the foot.

C177. United States Government Master Specification for the Construction of Built-Up Roofing, Type 5TCS.

Roofing of type 5TCS consists of five layers of coal-tar-saturated rag felt cemented together with coal-tar pitch and surfaced with suitable surfacing materials. It is adapted to concrete and poured gypsum roof surfaces with inclines not exceeding 1 inch to the foot.

C178. United States Government Master Specification for the Construction of Built-Up Roofing, Type 4TWS.

Roofing of type 4TWS consists of four layers of coal-tar-saturated rag felt cemented together with coal-tar pitch and surfaced with suitable surfacing materials. It is adapted to roof surfaces of board sheathing with inclines not exceeding 3 inches to the foot or precast gypsum slabs or blocks with inclines not exceeding 1 inch to the foot.

C179. United States Government Master Specification for the Construction of Built-Up Roofing, Type 5TWS.

Roofing of type 5TWS consists of five layers of coal-tar-saturated rag felt cemented together with coal-tar pitch and surfaced with suitable surfacing materials. It is adapted to roof surfaces of board sheathing with inclines not exceeding 3 inches to the foot or precast gypsum slabs or blocks with inclines not exceeding 1 inch to the foot.

C180. United States Government Master Specification for the Installation of Metal Flashings with Built-Up Bituminous Roofing.

This specification covers the installation of all metal flashings and other metal fittings used in connection with built-up bituminous roofing in the angles formed where the roof surface abuts walls, curbs, ventilators, pipe, and other vertical surfaces.

C181. United States Government Master Specification for the Installation of Plastic Flashings with Built-Up Bituminous Roofing.

This specification covers the installation of plastic or bituminous base flashings with or without appropriate cap or counter flashings in connection with built-up bituminous roofing.

C182. United States Government Master Specification for Record and Copying Ink.

The specification covers iron gallo-tannate ink suitable for writing permanent records and for making one press copy. The formula for a standard ink is given. The tests by which samples are compared with the standard are described.

C183. United States Government Master Specification for Writing Ink.

The specification covers iron gallo-tannate writing fluid as ordinarily sold, and also concentrated ink and ink powders and tablets which, with the proper amount of water, will produce satisfactory writing ink.

The formula for a standard writing ink is given. The tests by which samples are compared with the standard are described.

C184. United States Government Master Specification for Red Ink.

The specification covers red ink for general writing. The formula for a standard ink is given. The tests by which samples are compared with the standard are described.

C185. United States Government Master Specification for Stamp-Pad Ink.

The specification covers stamp-pad ink, black, blue, green, red, and violet, for use with rubber stamps. Formulas for standard inks of the above colors are given. The tests by which samples are compared with the standards are described.

C186. United States Government Master Specification for Typewriter Ribbons.

The specification covers the following ribbons: Black record, black copying blue, blue record, red and black record, and red and black copying. The tests for determining the quality are described.

C187. United States Government Master Specification for Hectograph Ribbons.

The specification covers single-color purple ribbons and two-color purple and red ribbons. Tests for determining the quality are described.

C188. United States Government Master Specification for Ribbons for Computing and Recording Machines.

The specification covers ribbons of the following types: Single color, black, blue, purple, and red record; black, blue, purple, and red copying; bichrome; trichrome. Tests for determining the quality are described.

C189. Recommended Specification for Quicklime and Hydrated Lime for Use in the Absorption of Carbon Dioxide.

Carbon dioxide may be removed from mixtures of gases by absorption, using lime. Two methods are employed. Hydrated lime may be moistened and spread out in thin layers, over which the gas to be purified passes, or the gas may be scrubbed with a milk of lime, made from either quicklime of hydrated lime. Quicklime should contain not less than 90 per cent available lime and hydrate not less than 85 per cent available lime. Hydrate should have a fineness of 97 per cent through a No. 200 screen.

C190. United States Government Master Specification for Plain, Inlaid, and Printed Linoleums.

This specification covers the common household grades of linoleum, which are plain, jaspe, granite, straight line, and molded inlaid, and printed linoleums. These linoleums are composed essentially of linseed oil and ground cork and pigments. Requirements as to general appearance, seasoning, weight and thickness, pliability, and resiliency are given. Methods for sampling and laboratory examination are also covered.

C191. United States Government Master Specifications for Battleship Linoleum.

This specification covers the grades of battleship linoleum ordinarily known as A-gauge, three-sixteenths-inch, and 6 mm linoleum. Requirements are given concerning the weight, thickness, seasoning, pliability, water absorption, and resilience of the material. Methods of sampling and laboratory examination are included.

C192. United States Government Master Specification for Asphalt Prepared Roofing.

This specification covers medium and heavy weight, smooth roll or ready asphalt prepared roofing. Requirements as to appearance, weight, pliability, character of the felt, and saturation are given. Specifications for nails and lap cement are included. Methods of sampling and laboratory examination are given.

C193. United States Government Master Specification for Liquid Soap (for Laundry Use).

This specification was prepared by a technical committee of the Federal Specifications Board in cooperation with the soap committee of the soap section of the American Specialty Manufacturers Association. The specification covers the maximum and the minimum of the ingredients; also methods of sampling and laboratory examination, preparation of reagents, and basis of purchase.

C194. United States Government Master Specification for Milled Toilet Soap.

This specification was prepared by a technical committee of the Federal Specifications Board in cooperation with the soap committee of the soap section of the American Specialty Manufacturers Association. The specification covers the maximum and the minimum of the ingredients; also methods of sampling and laboratory examination, preparation of reagents, and basis of purchase.

C195. United States Government Master Specification for Powdered Soap (for Laundry Use).

This specification was prepared by a technical committee of the Federal Specifications Board in cooperation with the soap committee of the soap section of the American Specialty Manufacturers Association. The specification covers the maximum and the minimum of the ingredients; also methods of sampling and laboratory examination, preparation of reagents, and basis of purchase.

C196. United States Government Master Specification for Black Waterproof Drawing Ink.

The specification gives the requirements for black waterproof drawing ink, and describes the laboratory tests that are made in order to determine its quality.

C197. United States Government Master Specification for Indelible Marking Ink for Fabrics.

The specification gives the requirements for two kinds of indelible marking ink—for laundry and household use, and for blankets and unsized or unstarched goods. Laboratory tests for determining the quality of the ink are described.

C198. United States Government Master Specification for Sole Leather.

A purchase specification for sole leather, promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government, containing requirements regarding thickness, cracking, piping, water absorption, and chemical constituents, together with methods of inspection and tests.

C199. Specifications for Hand Operated Grain Hopper Scales.

Specifications covering essential details of design, manufacture, installation and performance, are given in this circular.

C200. United States Government Master Specification for Heavy Rust-Preventive Compound.

This specification was prepared by the technical committee on paints of the Federal Specifications Board after careful consideration of suggestions from manufacturers. The specification calls for a heavy rust-preventive compound of such a nature that it can be applied to metal parts by brushing, dipping, or spraying at a temperature not above 71° C. (160° F.) to form an adherent protective coating even under the most severe conditions, but which will remain in a nondrying easily removable condition.

C201. United States Government Master Specification for Quicklime for Structural Purposes.

The quicklime covered by this specification is of two types, namely, calcium and magnesium. It shall be at least 95 per cent calcium and magnesium oxides; the silicon, iron, and aluminum oxides shall not exceed 3 per cent if the sample is taken at the kiln, nor 10 per cent if taken elsewhere. The waste shall not be greater than 3 per cent by weight of the quicklime.

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C202. United States Government Master Specification for Vitrified Chinaware.

This specification, prepared for the Federal Specifications Board by its technical committee, gives a detailed description of each piece of ware for use of the various Government departments, which includes sizes, shapes, weights, tolerances, and also methods for testing such ware. Cross-section drawings of the various pieces are also included.

C203. Recommended Specification for Quicklime and Hydrated Lime for Use in the Manufacture of Calcium Arsenate.

Calcium arsenate is made by treating milk of lime with arsenic acid. For this purpose quicklime should be at least 92.5 per cent pure, hydrated lime 90 per cent, and should contain less than 1.5 per cent magnesia.

C204. United States Government Master Specification for Hydrated Lime for Structural Purposes.

Hydrated lime is a fine white powder produced by the action of water on quicklime. It consists essentially of calcium hydroxide naturally associated with more or less magnesium oxide or hydroxide. Two types of hydrated lime are covered by this specification. They are mason's and finishing. Hydrated lime shall contain 95 per cent calcium and magnesium oxides; not more than 5 per cent carbon dioxide if sampled at place of manufacture, nor 7 per cent if sampled elsewhere. A residue of not over 0.5 per cent shall be retained on a No. 30 sieve, nor more than 15 per cent on a No. 200 sieve. Hydrated lime shall be "sound," and finishing hydrated lime shall have a plasticity figure of not less than 200.

C205. United States Government Master Specification for Gypsum Plaster.

The specification covers four types of gypsum plaster, namely, wood-fibered plaster, neat plaster, sanded brown coat plaster, and sanded scratch coat plaster.

C206. United States Government Master Specification for Calcined Gypsum.

Calcined gypsum (plaster of Paris) is a fine white powder resulting from the partial dehydration of gypsum by means of heat. This specification covers three classes of calcined gypsum, namely, casting, general, and finishing. The material for any of these classes shall contain not less than 60.5 per cent by weight of $CaSO_4 1/2 H_2O$; shall have a tensile strength of not less than 200 lbs./in.^{2}; and a compressive strength of not less than 1,000 lbs./in.^{2} Each class shall have a specified fineness and may be retarded or unretarded.

C207. Recommended Specification for Limestone, Quicklime, Lime Powder, and Hydrated Lime for Use in the Manufacture of Sugar.

Lime is used in the sugar industry either to precipitate impurities from the juices or sirups or, in the Steffen process, to precipitate the sugar from impure solutions. For the former purpose either lump quicklime or hydrated lime may be used; for the latter purpose, very finely ground quicklime, known as lime powder, is required. For the purification of juices, 85 per cent purity is required of the lime or hydrate, or of the limestone from which they are made. When used in the Steffen process, lime powder must contain 90 per cent sugar soluble lime, and the quicklime or limestone used in making it must be correspondingly pure.

C208. United States Government Master Specification for Wire Rope.

This specification, for the use of the Government departments in purchasing wire rope, covers the materials and constructions of wire rope now used by two or more Government departments.

The tests for the material and for the wire rope are described in detail, and the last section contains information for users of wire rope on handling, seizing, cutting, clips, socketing, sheaves and drums, lubrication, safe loads, and uses for the different constructions.

C209. United States Government Master Specification for Oil Suction and Discharge Hose.

This specification presents detailed requirements covering the design, method of inspection, and materials used in the construction of oil hose of 4, 6, and 8 inch diameter. Briefly stated, the hose is made up with layers of cotton duck and rubber, reinforced with two helices of galvanized round spring steel wire.

C210. United States Government Master Specification for Gypsum Plaster Board.

Gypsum plaster board covered by this specification shall weigh not less than 1,500 pounds nor more than 2,000 pounds per 1,000 square feet; shall have breaking loads of not less than 20 or 40 pounds, respectively, when tested parallel or at right angles to the fibers of the surfacing material; and the edges and ends shall be reasonably straight and solid and the corners square.

C211. United States Government Master Specification for Gypsum Wall Board.

This specification covers gypsum wall board of two types, namely, boards with square edges and boards with rounded edges. Either type of board shall weight not less than 1,500 pounds nor more than 2,000 pounds per 1,000 square feet, and shall have breaking loads of not less than 32 or 60 pounds, respectively, when tested parallel or at right angles to the fibers of the surfacing material.

C212. United States Government Master Specification for Upholstery Leather.

A United States Government master specification for upholstery leather officially promulgated by the Federal Specifications Board on June 30, 1924, for the use of the departments and independent establishments of the Government. The specification covers three grades of dyed or coated upholstery leathers as follows: Grain (snuffed), machine buffed, and No. 1 split.

C213. United States Government Master Specification for Lace Leather.

A United States Government master specification for lace leather officially promulgated by the Federal Specifications Board on June 30, 1924, for the use of the departments and independent establishments of the Government. The specification covers lace leather in the form of cut laces and whole sides either alum, Indian, or chrome tanned.

C214. United States Government Master Specification for Medium and Light Rust-Preventive Compounds.

This specification was prepared by the technical committee on paints and oils of the Federal Specifications Board after careful consideration of suggestions from manufacturers. The specification calls for a medium and light grade of rust-preventive compound, both liquids at ordinary temperatures. The medium grade is intended for use as a nondrying protective coating for metal stored under shelter. The light grade is intended for use in certain cases (such as in the inclosed parts of machinery) where the medium grade would be of too heavy consistency.

C215. United States Government Master Specification for Outside White Titanium-Zinc Paint, Semipaste and Ready-Mixed.

This specification was prepared by the technical committee on paints and oils of the Federal Specifications Board after carefully considering suggestions from paint manufacturers. The specification covers requirements for a high-grade titanium-zinc paint for outside use, intended particularly to be used whenever large amounts of sulphide fumes might quickly discolor certain types of outside white paint. The pigment shall contain not less than 50 per cent titanium pigment and 40 per cent zinc oxide with a maximum allowance of 10 per cent extending pigment and shall be free from lead and sulphide sulphur. Details as to composition of semipaste and ready-mixed paint and methods of sampling and testing are included.

C216. United States Government Master Specification for Putty.

The specification was prepared by the technical committee on paints and oils of the Federal Specifications Board after carefully considering suggestions from paint manufacturers. The specification covers requirements for a high-grade putty for general use. The putty may be of two classes—whiting putty or white lead-whiting putty. The pigment in whiting putty shall consist of finely divided natural chalk with or without the addition of necessary tinting colors, and shall contain not less than 95 per cent calcium carbonate. The white lead-whiting putty shall contain not less than 10 per cent of white lead. Both classes of putty shall be free from grit, shall be practically neutral, and the liquid shall be entirely pure raw linseed oil. Details as to composition, methods of sampling, and testing are included.

C217. United States Government Master Specification for Surgeons' Rubber Gloves.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of surgeons' rubber gloves. The specification was prepared in cooperation with the Rubber Association of America.

C218. United States Government Master Specification for Rubber Dam.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber dams. The specification was prepared in cooperation with the Rubber Association of America.

C219. United States Government Master Specification for Rubber Bandages.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber bandages. The specification was prepared in cooperation with the Rubber Association of America.

C220. United States Government Master Specification for Stomach or Lavage Tube.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of stomach or lavage tubes. The specification was prepared in cooperation with the Rubber Association of America.

C221. United States Government Master Specification for Colon Tube.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of colon tubes. The specification was prepared in cooperation with the Rubber Association of America.

C222. United States Government Master Specification for Politzer Bags.

The specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of politzer bags. The specification was prepared in cooperation with the Rubber Association of America. The bag is made of rubber and is pear shaped with a capacity of 6, 8, or 10 ounces. The specification gives detailed requirements regarding the design and quality of materials used.

C223. United States Government Master Specification for Rubber Tips for Crutches.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber tips for crutches. The specification was prepared in cooperation with the Rubber Association of America.

C224. United States Government Master Specification for Rubber Pillowcases.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber pillowcases. The specification was prepared in cooperation with the Rubber Association of America.

C225. United States Government Master Specification for Rubber Catheters.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber catheters. The specification was prepared in cooperation with the Rubber Association of America.

C226. United States Government Master Specification for Rubber Finger Cots.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber finger cots. The specification was prepared in cooperations with the Rubber Association of America.

C227. United States Government Master Specification for Rubber Ice Bags.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber ice bags. The specification was prepared in cooperation with the Rubber Association of America. The bag is round or oval in shape, being made of rubber walls reinforced at seams and throat. The specification gives detailed requirements regarding the design and quality of materials used.

C228. United States Government Master Specification for Helmet-shaped Ice Bags.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of Helmet-shaped ice bags. The specification was prepared in cooperation with the Rubber Association of America. The bag is made of double-coated rubber sheeting with cloth insertion, the design being such as to form a helmet which can be changed into a circular-shaped ice bag. The specification gives detailed requirements regarding design and quality of materials used.

C229. United States Government Master Specification for Friction Tape.

This specification was officially adopted by the Federal Specifications Board on May 20, 1925, for the use of the departments and independent establishments of the Government in the purchase of friction tape. The specification was prepared in cooperation with the Rubber Association of America. The tape is intended to cover electrical insulation applied to wires and cables. It is made of cotton sheeting impregnated and coated on both sides with an adhesive and insulating rubber compound.

C230. United States Government Master Specification for Rubber Insulating Tape.

This specification was officially adopted by the Federal Specifications Board on May 20, 1925, for the use of the departments and independent establishments of the Government in the purchase of rubber insulating tape. The specification was prepared in cooperation with the Rubber Association of America. The tape is used for insulating joints in electric wires and cables. It is wound in rolls with a glazed cloth, linen, or parchment paper separator between adjacent layers.

C231. Recommended Specification for Quicklime and Hydrated Lime for Use in the Purification of Water.

In the treatment of water for public supplies lime is used alone or with iron sulphate or aluminum sulphate to produce a precipitate which assists in the clarification of the water and in the removal of bacteria by filtration. Lime is used sometimes to partially soften the water. Lime and soda ash are used together for softening water. Quicklime is generally used in municipal plants and hydrated lime in smaller plants. For these purposes quicklime should contain at least 90 per cent available lime and hydrated lime at least 90 per cent available calcium hydroxide.

C232. United Stated Government Master Specification for Rubber Goods (Methods of Physical Tests and Chemical Analyses).

This specification was officially adopted by the Federal Specifications Board on June 15, 1923, for the use of the departments and independent establishments of the Government in the purchase of materials covered by it. The procedure to be followed in conducting physical tests and chemical analyses of rubber goods and asbestos packings is described in detail.

C233. United States Government Master Specification for Tucks Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of tucks packing. This specification was prepared in cooperation with the Rubber Association of America. The packing consists of cotton canvas layers built up on the bias, and is of two types, round or square. The round packing has a rubber core unless otherwise specified.

C234. United States Government Master Specification for Wire Insertion Rubber Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of wire insertion rubber packing. The specification was prepared in cooperation with the Rubber Association of America. The packing is made of layers of rubber with a brass wire insertion for each one-sixteenth thickness of packing. The rubber compound contains not less than 60 per cent by volume of rubber.

C235. United States Government Master Specification for Rubber Packings and Gaskets (Molded, Sheet, and Strip).

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of rubber packings and gaskets (molded, sheet, and strip). The specification was prepared in cooperation with the Rubber Association of America. Three grades of packing are provided for, having a minimum of 80, 70, and 60 per cent of rubber by volume, respectively.

C236. United States Government Master Specification for Cloth Insertion Rubber Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of cloth insertion rubber packing. The specification was prepared in cooperation with the Rubber Association of America. The packing consists of alternate layers of rubber and fabric, with a layer of rubber on top and bottom. Two grades of packing are provided for. In Grade A, rubber layers contain not less than 70 per cent, and in Grade B not less than 55 per cent by volume of rubber.

C237. United States Government Master Specification for Low-Pressure Spiral Gland Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of low-pressure spiral gland packing. The specification was prepared in cooperation with the Rubber Association of America. The packing is made of slab stock built up of layers of duck impregnated with a rubber compound. There is a top and bottom cover of rubber. The packing is lubricated with mineral oil and dipped in graphite.

C238. United States Government Master Specification for Asbestos High-Pressure Rod Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of high-pressure rod packing. The packing is suitable for steam pressures up to 300 lbs./in.^{2} and temperatures up to 700° F. The packing is made from woven asbestos cloth, treated with a protective coating of rubber compound, wrapped tightly upon itself in layers.

C239. United States Government Master Specification for Flax Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of flax packing. The specification requires that packing be made from well cleaned best selected long-line flax, and that it shall be thoroughly and evenly impregnated with pure tallow. Detail requirements are given relative to the properties of the materials used, and tests.

C240. United States Government Master Specification for Diaphragm Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of diaphragm packing. The specification was prepared in cooperation with the Rubber Association of America.

C241. United States Government Master Specification for Compressed Asbestos Sheet Packing.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of compressed asbestos sheet packing. The specification was prepared in cooperation with the Rubber Association of America.

The packing is made in two grades—one for use in steam joints under a maximum pressure of 350 lbs./in.^{2} and a maximum temperature of 700° F., and for joints of internal combustion engines; the other for similar uses with maximum steam pressure of 300 pounds.

C242. United States Government Master Specification for Asbestos Metallic Cloth Gaskets.

This specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of asbestos metallic cloth gaskets. The gaskets are suitable for a steam pressure of 300 lbs./in.^{2} and a temperature of 300° F.

C243. United States Government Master Specification for Asbestos Metallic Cloth Sheet Packing.

The specification was officially adopted by the Federal Specifications Board on December 29, 1923, for the use of the departments and independent establishments of the Government in the purchase of asbestos metallic cloth sheet packing and gaskets for high-pressure steam. The packing is suitable for a steam pressure of 300 lbs./in.^{2} and a temperature of 300° F.

C244. United States Government Master Specification for Rubber Valves.

This specification was officially adopted by the Federal Specifications Board on December 24, 1923, for the use of the departments and independent establishments of the Government in the purchase of rubber valves. The specification was prepared in cooperation with the Rubber Association of America. There are three grades of valves provided for—hard, medium, and soft. The rubber compound must contain no rubber substitute of any kind, rubber that has been previously used, or reclaimed rubber.

C245. United States Government Master Specification for Surgical Operating Pads.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of surgical operating pads. The specification was prepared in cooperation with the Rubber Association of America. The operating pads are made of single-coated rubber sheeting. They are reinforced at seams and edges and are supplied with air valve in the inflating bulb and have an open type air cushion rim with plain bottom and drain apron, the design and construction being such as to make the pad reversible. The specification provides detail requirements regarding design, construction, dimensions, attachments, properties of materials used, and tests.

C246. United States Government Master Specification for Rubber Ring Cushions.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber ring cushions. The specification was prepared in cooperation with the Rubber Association of America. The cushions are made of rubber without cloth insertion. They are round in shape with an open center, two sizes being provided for, No. 8 and No. 10, with outside diameters 16 and 18 inches, respectively. The specification provides detail requirements regarding design, construction, dimensions, properties of the rubber compound used, and tests.

C247. United States Government Master Specification for Surgeons' Rubber Aprons.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of surgeons' rubber aprons. The specification was prepared in cooperation with the Rubber Association of America. The aprons are made in one piece from single or double coated rubber sheeting as specified. The specification provides detail requirements regarding design, dimensions, construction, properties of materials used, and tests.

C248. United States Government Master Specification for Rubber Hot-Water Bottles.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber hot-water bottles. The specification was prepared in cooperation with the Rubber Association of America. The bottles are oblong in shape, with rounded corners, and are made of rubber without cloth insertion. Four sizes are provided for with capacities of 1, 2, 3, and 4 quarts. The specification gives detail requirements regarding construction, fittings, properties of materials used, and tests.

C249. United States Government Master Specification for Cloth Inserted Hot-Water Bottles.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of cloth inserted hot-water bottles. The specification was prepared in cooperation with the Rubber Association of America. The bottles are of 3-quart capacity and are oblong in shape, with rounded corners, and are made of double-coated rubber sheeting. The specification provides detail requirements regarding design, construction, properties of materials used, and tests.

C250. United States Government Master Specification for Cloth Inserted Fountain Syringe.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of cloth inserted fountain syringes. This specification was prepared in cooperation with the Rubber Association of America. The syringe is of the 2-quart type, made of double-coated rubber sheeting, and is provided with 5 feet of ¼-inch rubber tubing, irrigating nozzles, and tube clamp. The specification provides detail requirements regarding design, construction, fittings, properties of materials used, and tests.

C251. United States Government Master Specification for Rubber Fountain Syringe.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber fountain syringes. The specification was prepared in cooperation with the Rubber Association of America. The syringes are of the 2-quart type and are made of a rubber compound without cloth insertion. They are supplied with 5 feet of ¼-inch rubber tubing, irrigating nozzles, and tube clamp. The specification provides detail requirements regarding design, construction, fittings, properties of the rubber compounds, and tests.

C252. United States Government Master Specification for Rubber Air Pillows.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber air pillows. The specification was prepared in cooperation with the Rubber Association of America. The pillows are made of single-coated rubber sheeting. The size is No. 3, approximately 18 inches long and 12 inches wide. A nickel-plated screw tightening air valve is provided. The specification provides detail requirements regarding design, construction, properties of the rubber compound and fabric, and tests.

C253. United States Government Master Specification for Rubber Sheeting.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of rubber sheeting. The specification was prepared in cooperation with the Rubber Association of America. The sheeting is made of cotton fabric, single or double coated with a rubber compound, as specified. It has a smooth uniform soft finish. The specification provides detail requirements regarding dimensions, properties of the rubber compound and fabric, and tests.

C254. United States Government Master Specification for Cloth Inserted Ring Cushions.

This specification was officially promulgated by the Federal Specifications Board on November 5, 1924, for the use of the departments and independent establishments of the Government in the purchase of cloth insertion ring cushions. The specification was prepared in cooperation with the Rubber Association of America. The cushions are made of single-coated rubber sheeting. They are round in shape with open center, two sizes being provided for, No. 8 and No. 10, with outside diameters of 16 and 18 inches, respectively. The specification provides detail requirements regarding design, construction, dimensions, properties materials used, and tests.

C255. United States Government Master Specification for Cheesecloth for Wiping Purposes.

This specification is intended to cover cheesecloth for wiping purposes. It may consist of seconds occurring in the manufacture of first-quality cheesecloth. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers' Association, so that the requirements specified are essentially in agreement with commercial practice.

C256. United States Government Master Specification for Brown Denim (Shrunk).

This specification is intended to cover the Government's requirements for shrunk brown denim. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers' Association, so that the requirements are essentially in agreement with commercial practice.

C257. United States Government Master Specification for Cheesecloth, Bleached or Semibleached.

This specification is intended to cover bleached or semibleached cheesecloth, 36-inch width. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C258. United States Government Master Specification for Cheesecloth, Unbleached.

This specification is intended to cover the Government's requirements for unbleached cheesecloth. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C259. United States Government Master Specification for Brown Denim (Unshrunk).

This specification is intended to cover the Government's requirements for unshrunk brown denim. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C260. United States Government Master Specification for Wool Waste, Colored.

This specification is intended to cover the Government's requirements for wool waste, colored. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the American Cotton Waste Exchange and the research and standardization committee for the Wool Industry, so that the requirements as specified are essentially in agreement with commercial practice.

C261. United States Government Master Specification for Colored Cotton Rags, for Wiping Machinery (Sterilized).

This specification is intended to cover the Government's requirements for colored cotton rags, for wiping machinery (sterilized). This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C262. United States Government Master Specification for Cotton Waste, White.

This specification is intended to cover the Government's requirements for cotton waste, white. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the American Cotton Waste Exchange, so that the requirements as specified are essentially in agreement with commercial practice.

C263. United States Government Master Specification for Cotton Waste, Colored.

This specification is intended to cover the Government's requirements for cotton waste, colored. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the American Cotton Waste Exchange, so that the requirements are essentially in agreement with commercial practice.

C264. United States Government Master Specification for White Cotton Rags for Wiping Machinery (Sterilized).

This specification is intended to cover the Government's requirements for white cotton rags for wiping machinery (sterilized). This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C265. United States Government Master Specification for Indigo Blue Denim (Shrunk).

This specification is intended to cover the Government's requirements for indigo blue denim (shrunk). This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C266. United States Government Master Specification for Indigo Blue Denim (Unshrunk).

This specification is intended to cover the Government's requirements for indigo blue denim (unshrunk). This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the National Association of Cotton Manufacturers and the American Cotton Manufacturers Association, so that the requirements specified are essentially in agreement with commercial practice.

C267. United States Government Master Specification for Wiping Cloths.

This specification is intended to cover new material, free from starch, used for wiping purposes. This specification was prepared by the technical committee on textiles of the Federal Specifications Board and officially promulgated December 6, 1924. In its preparation the committee had the cooperation of the American Cotton Waste Exchange, so that the requirements as specified are essentially in agreement with commercial practice.

HANDBOOKS

[For publications in following list that are out of print or procurable only from Superintendent of Documents, Government Printing Office, Washington, D. C., see the supplement to this circular.]

H1. Manual of Inspection and Information for Weights and Measures Officials. (Superseding M1.)

This manual is designed primarily for official sealers and inspectors appointed to enforce weights and measures laws or ordinances, but it will also be of use to any one who has occasion to inspect and test weights and measures and weighing and measuring devices of the types ordinarily found in commercial use. It contains specifications and tolerances and complete instructions for the testing of all kinds of scales, length measures, liquid and dry capacity measures, etc.; general instructions concerning the enforcement of law; lists of standards and apparatus; a method of keeping office records, etc. Appendixes are included containing Federal weights and measures laws, with rules and regulations, the model State law in relation to weights and measures, a description of the metric system, and general tables, conversion tables, and tables of equivalents. (Nov. 14, 1918.) 246 pp. Price, 50 cents.

H2. National Safety Code for the Protection of the Heads and Eyes of Industrial Workers.

This is a set of rules designed to give mechanical and optical protection to the eyes of workers in certain occupations which involve eye hazard. The rules have been worked up in cooperation with a sectional committee of the American Engineering Standards Committee.

The rules are accompanied by a discussion intended to assist in their interpretation and application and to show the reasons for including some of them in the text. (Dec., 1920.) 64 pp. Price, 10 cents.

H3. National Electrical Safety Code. (Superseding C54.)

A code of rules for electrical construction and operation in four parts. Part 1 deals with electrical generating stations and substations and specifies appropriate guarding, isolation or grounding of live parts and machine frames and provides adequate working spaces. Part 2 deals with electrical overhead and underground line construction, specifying minimum clearances and strength of construction. Part 3 deals with utilization equipment in factories and elsewhere in a manner similar to Part 1. Part 4 gives operating rules for employers and employees in the electrical industry. A supplementary section gives rules for grounding equipment and lines. (Oct. 31, 1920.) 366 pp. Price (cloth bound), 40 cents.

H4. Discussion of the National Electrical Safety Code. (Superseding C54.)

This publication contains a discussion of the rules of the National Electrical Safety Code as published in Handbook No. 3. The discussion is intended to give the reasons for inserting some of the rules, to aid in the interpretation of the rules, to give suggestions as to how the rules may be applied and suggestions regarding practice involved in the rules. In the present edition, it has for convenience been segregated under a separate cover from the rules themselves. This discussion was originally included in Circular 54, but has been amplified and considerably extended in scope. (Oct. 31, 1920.) 330 pp. Price (cloth bound), 40 cents.

H5. American Logging and Sawmill Safety Code.

This code presents methods of eliminating or minimizing hazards met with in felling trees, handling logs on skidders, log chutes, sleds, the transportation of logs to the mill on logging railroads; river driving and rafting and transportation and use of inflammable liquids and explosives. Part 2 deals with the layout of sawmills, the guarding of sawmill machinery and methods of handling logs and lumber in the mill. A third part deals with yard and dry-kiln operations. An illustrated discussion of the rules is included. Oct. 12, 1923. 140 pp. Price, 60 cents.

SIMPLIFIED PRACTICE RECOMMENDATIONS.

[For publications in the following list that are out of print or procurable only from the Superintendent of Documents, Government Printing Office, Washington, D. C., see the supplement to this Circular.]

R1. Elimination of Waste—Simplified Practice Recommendation No. 1.—Paving Bricks.

Specific example of the application of the principle of simplification to the paving brick industry. Describes the need for eliminating economic waste caused by the excessive variety in types and sizes of paving bricks and shows the procedure used in reducing existing varieties from 66 to 7.

The industry initiated the action through its trade association, and the Government, through the Department of Commerce, indorses and publishes as its own those simplifications recommended by joint conferences of producers, distributers and users of the commodity.

These simplified practice recommendations when accepted by the entire industry serve as commercial standards of practice with consequent benefit through decreased stocks, costs, and investments, and increased sales, turnover, and income.

In order to further simplify the production of paving brick, the conference of 1923 eliminated an additional type of brick, reducing the 7 recognized types and sizes to 6. This procedure was based upon a resurvey by the Paving Brick Association, which showed that 80 per cent of the entire production during 1922 was within the 6 varieties. Price, 5 cents.

R2. Elimination of Waste—Simplified Practice Recommendation No. 2.—Bedsteads, Springs, and Mattresses.

Since the inception of the division of simplified practice, conferences of representatives of manufacturers, distributers, and users are held to determine and eliminate excess varieties and types of products with a view to simplifying their lines in the production of commodities. On May 15, 1922, representatives of the bed, spring, and mattress industry convened at the department in cooperation with the division of simplified practice, and adopted four standard widths of beds of one standard length, springs and mattresses to conform therewith. These recognized sizes and types will be considered as standards, subject to annual revision by a similar conference. Price, 5 cents.

R3. Elimination of Waste—Simplified Practice Recommendation No. 3.—Metal Lath.

The elimination of waste program which was considered by manufacturers, distributers, and users of metal lath at a general conference with the division of simplified practice, Department of Commerce, on December 12, 1922, has since sustained obviously desired modifications, and is now ready for publication in the Department's "Elimination of waste" series, and is effective July 1, 1924. While this program represents an 80.8 per cent elimination of varieties of metal lath, the industry intends to make every effort to direct practice to a consolidation of certain weights, so that the eventful list will be the survival of an 84 per cent elimination. Price, 5 cents.

R4. Elimination of Waste—Simplified Practice Recommendation No. 4.—Asphalt.

In accordance with the unanimous action on May 28, 1923, of the joint conference of representatives of manufacturers, distributers, and users of asphalt for paving purposes the United States Department of Commerce, through the Bureau of Standards, recommends that recognized varieties of paving asphalt be reduced to those shown in the tables printed in this publication. Price, 5 cents.

R5. Elimination of Waste—Simplified Practice Recommendation No. 5.—Hotel Chinaware.

Through the joint efforts of the American Hotel Association and the American Vitrified China Manufacturers Association, the division of simplified practice was asked to cooperate in effecting a general reduction in the types and shapes of hotel chinaware. Meetings of the committees representing the former two associations resulted in the adoption of a proposed set of standards, which was submitted at a general conference at the Department of Commerce on May 28, 1923. Having had some 700 varieties of hotel chinaware, the representatives at this conference eliminated all but 160, which they considered were sufficient to meet the needs of the trade. The results of this unanimous action are now being published in the Elimination of Waste Series of the Department of Commerce under the title Simplified Practice Recommendation No. 5, Hotel Chinaware. Price, 5 cents.

R6. Elimination of Waste—Simplified Practice Recommendation No. 6.—Files and Rasps.

In an effort to reduce the waste now prevalent in the hardware industry through the production of a vast variety of commodities, the manufacturers of files and rasps met in a general conference under the supervision of the division of simplified practice of the Department of Commerce, together with distributers and users, to consider the reduction in variety of these commodities.

This group, in cooperation with the War Industries Board during 1918 eliminated 732 sizes and types of files and rasps, and the enormous saving resulting therefrom prompted them to consider further elimination at the conferences on February 1, 1923, in New York, N. Y., and October 15, 1923, at Atlantic City, N. J. Four hundred and ninety-six varieties are to be the recognized types and sizes for a period of one year. Price, 5 cents.

R7. Elimination of Waste—Simplified Practice Recommendation No. 7.—Face Brick and Common Brick.

In accord with the desires of the industries concerned, as expressed at the preliminary conference with the division of simplified practice, Department of Commerce, on May 11, 1923, a general conference was held at the department on June 21 to consider the reduction of various sizes and types of common and face brick. Representatives of manufacturers, distributers, and users were present, and the deliberations of this conference led up to unanimous approval of standard sizes—for common brick, 8 by 2¼ by 3¾; textured face brick, 8 by 2¼ by 3¾; smooth face brick, 8 by 2¼ by 3⅞. Although these sizes are now in general use throughout the industry, it is thought that the moral backing of the Department of Commerce would result in greater adherence. These sizes, together with a brief report of the conference, are listed in an Elimination of Waste series of the department under the title of Simplified Practice Recommendation No. 7. Price, 5 cents.

R8. Elimination of Waste—Simplified Practice Recommendation No. 8.—Range Boilers and Expansion Tanks.

Simplified Practice Recommendation No. 8 is one of the series on the Elimination of Waste and contains a brief account of the conference as well as two tables showing the proposed sizes and capacities of range boilers and expansion tanks. This conference was held under the auspices of the division of simplified practice on October 30, 1923, and the recommendations are the result of unanimous vote of representatives of manufacturers, distributers, and users in attendance. It is estimated that approximately $5,000,000 will be saved annually to the ultimate consumer through this constructive action. Price, 5 cents.

R9. Elimination of Waste—Simplified Practice Recommendation No. 9.—Woven Wire Fencing.

Simplified Practice Recommendation No. 9, of the Elimination of Waste series, covering woven wire fencing, proposed by the manufacturers and accepted by the distributers and consumers of this commodity and approved by Department of Commerce, results in a reduction from 552 styles of woven wire fence to 69 and a reduction from 2,072 sized packages to 138. Price, 5 cents.

R10. Elimination of Waste—Simplified Practice Recommendation No. 10.—Milk and Cream Bottles and Bottle Caps.

In conjunction with manufacturers, distributers, and users of milk and cream bottles and bottle caps, the division of simplified practice and the ceramics division of the Bureau of Standards held a general conference at the Department of Commerce and effected a simplification resulting in the adoption of three standard heights for quart, pint, and half-pint milk and cream bottles, respectively, and of one standard cap for the entire group. This recommendation is part of the series on Elimination of Waste and is effective January 1, 1924. Price 5 cents.

R11. Elimination of Waste—Simplified Practice Recommendation No. 11.—Bed Blankets.

Simplified Practice Recommendation No. 11, is one of the series on the elimination of waste in industry and covers recommendation developed through the unanimous action of the joint conference of representatives of manufacturers, distributers, and users of bed blankets. This conference was held under the auspices of the division of simplified practice of the Department of Commerce, on February 1, 1924, and the recommendations covering a reduction from 78 to 12 sizes of cotton, wool, and cotton and wool mixed bed blankets are to become effective as applying to new production November 1, 1924. Price 5 cents.

R12. Elimination of Waste—Simplified Practice Recommendation No. 12.—Hollow Building Tile.

In accordance with the program of the Department of Commerce, in cooperation with American industries tending toward the elimination of industrial waste, manufacturers, distributers, and users of hollow tile met in a joint conference on October 19, 1923, and adopted a simplified list of sizes and weights of this commodity. This list comprises 19 varieties of weights and sizes and is a reduction from 36 as formerly manufactured. It is effective January 1, 1924, and is to remain in force for a period of one year from that date. Price, 5 cents.

R13. Elimination of Waste—Simplified Practice Recommendation No. 13.—Structural Slate.

Simplified Practice Recommendation No. 13 is one of the series of publications on the elimination of waste in industry, and covers recommendations developed through the unanimous action of the joint conference of representatives of manufacturers, distributers, and users of structural slate. This conference was held under the auspices of the division of simplified practice of the Department of Commerce January 23, 1924, and the recommendations as approved cover a simplified list of sizes and nomenclature for structural slate for plumbing and sanitary purposes, to become effective January 1, 1925. Price, 5 cents.

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R14. Elimination of Waste—Simplified Practice Recommendation No. 14.—Roofing Slate.

Simplified Practice Recommendation No. 14 covers the recognized sizes and nomenclature of slate for roofing purposes, adopted at a joint meeting of the manufacturers, distributers, and users held on January 23, 1924, and unanimously recommended to take effect July 1, 1924, subject to annual revision. This recommendation will bring about the elimination of waste of an important natural resource, and will make it unnecessary to wait for specified sizes while an accumulated finished stock of other usable sizes is available and immediately accessible. The immediate effect of this measure involves a reduction from 60 sizes of roofing slate to 30; a reduction from 21 thicknesses to 10; and a reduction from 17 descriptive terms to 8; corresponding to respective eliminations of 50, 52, and 52.9 per cent. Price, 5 cents.

R15. Elimination of Waste—Simplified Practice Recommendation No. 15.—Blackboard Slate.

Simplified Practice Recommendation No. 15 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess varieties of blackboard slate. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, distributers, and users are to be effective from January 1, 1925. Price, 5 cents.

R16. Elimination of Waste—Simplified Practice Recommendation No. 16.—Lumber.

The simplification of lumber sizes, grades, nomenclature, and trade practices was started early in 1919 through the American Lumber Congress in cooperation with the Forest Products Laboratory. The inception of the division of simplified practice early in 1922 provided a service for carrying forward this work, and the lumber industry immediately availed themselves of this cooperation. Two general conferences consisting of representatives of all interests were held in December, 1923, and April, 1924, with the result of definite recommendations being adopted. A complete history of the lumber simplification, together with the recommendations, is published in detail in the Department of Commerce Elimination of Waste series under the title Simplified Practice Recommendation No. 16.—Lumber. Price, 15 cents.

R17. Elimination of Waste—Simplified Practice Recommendation No. 17.—Forged Tools.

This recommendation covers the unanimous action of conferees assembled in a general conference at the Department of Commerce on February 11, 1924. A survey was made by the Forged Tool Societies showing the diversity existing in the production of forged tools. As a result a general conference of manufacturers, distributers, and users of this commodity was called, and after deliberation it was unanimously passed that the sizes and types of picks, mattocks, and hoes be reduced from 101 to 49; bars from 58 to 26; wedges from 105 to 67; sledges and heavy hammers from 243 to 111, and anvil and blacksmith tools from 158 to 98. The recommendation contains the sizes and types of forged tools now considered as standard of practice. Price, 5 cents.

R18. Elimination of Waste—Simplified Practice Recommendation No. 18.—Builders Hardware.

The simplification of builders hardware was begun by the Advisory Committee on the Standardization of Builders Hardware, a committee established under the Bureau of Standards as an outgrowth of the preparation of specifications for this commodity by the Federal Specifications Board, and was approved at a general conference consisting of representatives of all interests at the Department of Commerce. The recommendations cover standard rules, practices, finishes, types, and sizes of the more important classes of builders hardware. Price, 10 cents.

R19. Elimination of Waste—Simplified Practice Recommendation No. 19.—Asbestos Paper and Asbestos Millboard.

Recommendation No. 19 results from a general conference of manufacturers, distributers, and consumers of asbestos paper and asbestos millboard held at the Department of Commerce on May 22, 1924. Although a young industry, a strong tendency toward overdiversity in sizes and weights of asbestos paper and millboard has been very prevalent, and the leaders in the industry felt that the time was opportune to effect standards for their manufacture and consumption. The conference decided upon an elimination of seven sizes of asbestos paper in rolls with a subsequent reduction from eight to five weights, and in asbestos millboard from three sizes to one, with a corresponding reduction from seven to four thicknesses. The recommendation gives a brief history of the production of asbestos, its adaptability to manufacture, as well as a résumé of the preliminary conference, survey, and general conference. Price, 5 cents.

R20. Elimination of Waste—Simplified Practice Recommendation No. 20.—Steel Barrels and Drums.

Simplified Practice Recommendation No. 20 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess varieties of steel barrels and drums. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, distributers, and users, are to become effective January 1, 1925. Price, 5 cents.

R21. Elimination of Waste—Simplified Practice Recommendation No. 21.—Brass Lavatory and Sink Traps.

Simplified Practice Recommendation No. 21 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in a movement to eliminate excess varieties of brass lavatory and sink traps. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, distributers, and consumers, are to be effective from January 1, 1925. Price, 5 cents.

R22. Elimination of Waste—Simplified Practice Recommendation No. 22.—Paper.

This recommendation contains the results arrived at, and procedure followed by the committee and subcommittees appointed through the Bureau of Standards for the purpose of simplifying paper sizes.. The reports were submitted by the chairmen of these committees at a general conference held at the Bureau of Standards, June 19, 1923. Although these reports contained many constructive recommendations, it was the sense of the conference that as an initial step its action be limited to the support of eight principal sizes with their doubles and that all paper substance weights, shall be stated in terms of the basic 25 by 40-inch size. Included in this recommendation is a list of the personnel attending the conference, paper sizes adopted, and a brief statistical summary of the industry as a whole. Price, 5 cents.

R23. Elimination of Waste—Simplified Practice Recommendation No. 23.—Plow Bolts.

Simplified Practice Recommendation No. 23 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of plow bolts. Price, 5 cents.

R24. Elimination of Waste—Simplified Practice Recommendation No. 24.—Hospital Beds.

Simplified Practice Recommendation No. 24 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the first general conference, and the results obtained in an effort to eliminate excess varieties of hospital beds. The specific recommendations of the general conference covered in this publication, which have been accepted by a representative group of manufacturers, distributers, and consumers, are to become effective January 1, 1925. Price, 5 cents.

R25. Elimination of Waste—Simplified Practice Recommendation No. 25.—Hot Water Storage Tanks.

Simplified Practice Recommendation No. 25 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of sizes of hot water storage tanks. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective January 1, 1925. Price, 5 cents.

R26. Elimination of Waste—Simplified Practice Recommendation No. 26.—Steel Reinforcing Bars.

Simplified Practice Recommendation No. 26 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess varieties of steel reinforcing bars. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, distributers, and users, are to become effective for new production on January 1, 1925. Price 5 cents.

R27. Elimination of Waste—Simplified Practice Recommendation No. 27.—Cotton Duck (Wide and Sail).

Simplified Practice Recommendation No. 27 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of widths and weights of wide and sail cotton duck. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective November 1, 1924. Price, 5 cents.

R28. Elimination of Waste—Simplified Practice Recommendation No. 28.—Sheet Steel.

Simplified Practice Recommendation No. 28 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the results obtained in an effort to eliminate excess variety of sizes and thicknesses of sheet steel. The specific recommendations of the general conference covered in the publication, which have been accepted by manufacturers, users, and distributers, are to become effective January 1, 1925. Price, 5 cents.

R29. Elimination of Waste.—Simplified Practice Recommendation No. 29.—Eaves Trough and Conductor Pipe.

Simplified Practice Recommendations No. 29 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the results obtained in an effort to eliminate the excess variety of sizes and weights of eaves trough and conductor pipe. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective July 1, 1925. Price, 5 cents.

R30. Elimination of Waste—Simplified Practice Recommendation No. 30.—Terneplate.

Simplified Practice Recommendation No. 30 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of weights and thicknesses of terneplate. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective January 1, 1925. Price, 5 cents.

R31. Elimination of Waste—Simplified Practice Recommendation No. 31.—Loaded Paper Shot Shells.

Simplified Practice Recommendation No. 31 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety in loaded shells. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective January 1, 1925. Price, 5 cents.

R32. Elimination of Waste—Simplified Practice Recommendation No. 32.—Concrete Building Units (Blocks, Tile, and Bricks).

Simplified Practice Recommendation No. 32 is one of a series of publications on the elimination of waste in industry. It contains the history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of lengths, widths, and heights of concrete building units. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective June 1, 1925. Price, 5 cents.

R33. Elimination of Waste—Simplified Practice Recommendation No. 33.—Chinaware (Cafeteria and Restaurant).

Simplified Practice Recommendation No. 33 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of sizes and types of cafeteria and restaurant chinaware. The specific recommendation of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective January 1, 1925. Price, 5 cents.

R35. Elimination of Waste—Simplified Practice Recommendation No. 35.—Steel Lockers (Single and Double Tier).

Simplified Practice Recommendation No. 35 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and the result obtained in an effort to eliminate excess variety of sizes of single and double tier steel lockers. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective April 1, 1925. Price, 5 cents.

R36. Elimination of Waste—Simplified Practice Recommendation No. 36.—Milling Cutters.

Simplified Practice Recommendation No. 36 is one of a series of publications on the elimination of waste in industry. It contains a history of the development, report of the general conference, and styles and sizes of milling cutters. The specific recommendations of the general conference covered in this publication, which have been accepted by manufacturers, users, and distributers, are to become effective July 1, 1925, for new production and January 1, 1926, for existing stocks subject to regular annual revision by the conference of the standing committee. Price, 5 cents.

RX. Elimination of Waste—Simplified Practice in the Marine Field—Organization of the American Marine Standards Committee and its Constitution and Rules.

Publishes plan, constitution, and rules of an organization to embrace all interests in marine activities and formed as a result of initial cooperation between the Department of Commerce, the United States Shipping Board, and the American Marine Association with the object of effecting economy in construction, operation, and maintenance costs of ships and port facilities. The plan of the organization is pointed out by the division of simplified practice as suitable in principle to other industrial and commercial groups interested in organized effort to simplify practice and eliminate waste. 18 pp. Price, 5 cents.

RXI. Elimination of Waste—Simplified Practice—What It Is and What It Offers.

This publication contains a detailed statement of the procedure of the division of simplified practice in connection with its program tending toward the elimination of industrial waste. It also summarizes the accomplishments of trade associations, individual businesses and the Government in the application of simplified practice. A detailed list is included, giving the simplified practice recommendations which have been effected in cooperation with American industries. A foreword by Secretary Hoover as to the value of eliminating industrial waste is one of its prominent features. Price, 10 cents.

LIMITATION OF VARIETY RECOMMENDATIONS

L1. Elimination of Waste—Limitation of Variety Recommendation No. 1.—Paints and Varnishes.

During the war paint manufacturers, in cooperation with the War Industries Board, adopted a restricted list of colors, tints, shades of paint and varnishes, as well as of definite sized containers. However, immediately after the war a growing tendency to return to the former varieties was shown throughout the industry. The leading manufacturers were of the opinion that this war-time schedule should be maintained, and, after several conferences under the guidance of the division of simplified practice, it was unanimously approved at a joint conference of manufacturers, distributers, and users that the war-time schedule should be reaffirmed and considered as the recognized standard of practice for the industry for a period of one year effective September 1, 1924. This Limitation of Variety Recommendation No. 1 gives in detail the entire procedure and the list of preferred colors and containers. 8 pp. Price, 5 cents.

BUILDING AND HOUSING

BH1. Recommended Minimum Requirements for Small Dwelling Construction.

The report describes circumstances leading to appointment of Department of Commerce Building Code Committee; preliminary investigational work carried on by committee; details of measures for obtaining information on special questions; and cooperation extended by various interested organizations. It presents complete requirements for construction of small dwellings, in form suitable for adoption by States and cities. The requirements include sections on masonry walls of all types used in such structures; frame dwellings, with and without veneer of brick, stone, or stucco; wood framing in masonry structures; floor and roof loads; plastering; fire-stopping; and chimney construction.

A voluminous appendix is added to the report which explains reasons for many of the provisions recommended and gives much practical information on building materials and methods and also includes numerous illustrations of approved building practice. (July 20, 1922.) 108 pp. Price, 15 cents.

BH2. Recommended Minimum Requirements for Plumbing in Dwellings and Similar Buildings.

The justice and particularly the scientific bases of plumbing regulations have been much questioned. The committee of experienced sanitary engineers, appointed by Secretary Hoover, supervised extensive investigations at the bureau to settle these disputed problems.

Their report described variations in present plumbing practice as influenced by State and city codes; presents a recommended plumbing code for dwellings and similar buildings for use of those writing or revising plumbing codes; discusses many of the mooted points in plumbing regulation, and includes a detailed report of extensive test series with domestic plumbing equipment, carried on at the Bureau of Standards.

The recommended plumbing code is based on the results of the experimental work described and permits important modifications of present code requirements leading to considerable economies in the design of plumbing systems. (July 3, 1923.) 260 pp. Price, 35 cents.

BH3. A Zoning Primer.

The object of a Zoning Primer is to give a readable presentation of the subject in brief compass. It defines zoning and explains the need for dividing growing cities and towns into districts in which the use to which buildings may be put, their height, and the area of the lot which they may cover are regulated. It tells how zoning protects property and health and reduces the cost of living. It explains that zoning is legal, and how to get a zoning program started, and concludes with a statement of what a number of cities and towns have accomplished by zoning. 7 pp. Price, 5 cents.

BH4. How to Own Your Home: A Handbook for Prospective Home Owners.

This pamphlet is designed as a handbook for prospective home owners. After a discussion of some general factors, such as the arrangement of safe expenditure, and the percentage of income to devote to payments, it takes up the importance of having agreements in regard to financing, building, and purchasing, properly signed by both parties and drawn with careful attention to legal details. Various methods of financing and the principal types of institutions that lend to home seekers are described. Considerations governing the choice of a lot, house plans and quality of construction, the question of buying or building, the procedure and precautions to be taken when either course is chosen, and maintenance costs and expenses of home ownership are treated separately. An appendix contains financing tables and examples of typical financing transactions. 28 pp. Price, 5 cents.

BH5. A Standard State Zoning Enabling Act.

This act was drafted to meet the needs of States wishing to adopt legislation permitting municipalities to adopt zoning regulations. Since it was first issued in mimeograph form in August, 1922, at least 15 States have passed zoning enabling acts modeled either wholly or partly after it. Before the act was issued, existing State acts and court decisions with reference to zoning as it has been practiced and found successful in cities and towns throughout the country, were carefully studied. The act is accompanied by ample notes which explain the desirability of having a carefully prepared act and which give the reasons for the substance and phraseology of many of the provisions. The eight sections of the act deal with the following subjects: Grant of power, districts, purposes in view, method of procedure, changes, zoning commission, board of adjustment, and remedies. 12 pp. Price, 5 cents.

BH6. Recommended Minimum Requirements for Masonry Wall Construction.

The third report of the Department of Commerce Building Code Committee presents a model code for regulation of masonry, including walls of brick, tile, concrete units, stone, and plain concrete. The introduction describes variations and inconsistencies in present code requirements and the methods utilized by the committee in drafting the recommended code. Careful investigations were made of data obtained by tests of masonry materials and walls, and successful experience in many localities was consulted. This information is given in an appendix to the report, together with such other material of interest to builders. (June 26, 1924.) 57 pp. Price, 15 cents.

BH7. Minimum Live Loads Allowable for Use in Design of Buildings.

The fourth report of the Department of Commerce Building Code Committee presents live-load requirements recommended for general adoption by States and municipalities with the object of preserving safety, stimulating uniformity of requirements, and conserving materials and labor. The introduction describes variations and inconsistencies in present code requirements and cites investigations made. A great deal of test data, actual live-load measurements and observations were obtained from those who have studied the subject. This information is given in an appendix to the report, together with much other interesting material. (Nov. 1, 1924.) 38 pp. Price, 10 cents.

MISCELLANEOUS PUBLICATIONS

For publications in following list that are out of print or procurable only from Superintendent of Documents, Government Printing Office, Washington, D. C., see the supplement to this Circular.]

M1. Manual of Inspection and Information for Weights and Measures Officials.

This manual is designed primarily for official sealers and inspectors appointed to enforce weights and measures laws or ordinances, but it will also be of use to anyone who has occasion to inspect and test weights and measures and weighing and measuring devices of the types ordinarily found in commercial use. It contains specifications and tolerances and complete instructions for the testing of all kinds of scales, length measures, liquid and dry capacity measures, etc.; general instructions concerning the enforcement of law; lists of standards and apparatus; a method of keeping office records, etc. Appendixes are included containing Federal weights and measures laws, with rules and regulations, the model State law in relation to weights and measures, a description of the metric system, and general tables, conversion tables, and tables of equivalents. (Nov. 14, 1918.) 246 pp. [Superseded by H1.]

M2. The International Metric System of Weights and Measures.

This pamphlet gives a brief historical sketch and description of the metric system, its various units and their uses, shows the methods of formation of the various tables, and closes with the statement of the legal status of the metric system in the United States and two pages of equivalents of customary and metric measures. 15 pp. Price, 5 cents.

M3. The International Metric System. (Chart.)

This graphic chart is printed in colors and shows the comparison of the customary with the metric weights and measures, including the yard, meter, avoirdupois pound, half troy pound; quart, liter, and liquid quart; foot and 3 decimeters; inch and 25 millimeters. The chart is designed for use in schools, laboratories, shops, and exporting and importing offices. It gives a concise statement of the metric system and the method of forming names of the units and the tables and gives the more important equivalents between the customary and the metric measures. Price, 25 cents.

M4. First Annual Conference on the Weights and Measures of the United States (1905).

Contains a record of the proceedings of the first meeting of State weights and measures officials and other delegates, which was called by the Bureau of Standards with the intention of assisting weights and measures officials so as to enable them to make a thorough and efficient inspection and test of weights and measures. A further purpose was to bring about a close cooperation between the State officials and the Bureau of Standards, with a view to obtaining the enactment of proper weights and measures laws in the States with as high a degree of uniformity among them as the varying conditions in the different States would permit, and to the end that the benefits of a proper enforcement of adequate laws on this subject might be brought to the people. A paper was read at this conference giving a short history of the standard weights and measures of the United States, tracing the source of the fundamental standards recognized in this country and including a list of the standards furnished the various States by the Federal Government, and reports were given by the delegates on the status of the weights and measures situation in their respective States. The laboratories of the Bureau were open to the delegates so that they might get information as to methods employed at the Bureau in testing weights and measures and weighing and measuring apparatus. 46 pp. Price, 10 cents.

M5. Second Annual Conference on the Weights and Measures of the United States (1906).

At this meeting reports were made by the delegates on various questions affecting weights and measures in their respective States, bringing out the extent of the organization of weights and measures work in the different States represented, and throwing light upon various ways in which fraud is perpetrated on the public; a paper was read by the secretary of the conference dealing with the weights and measures inspection services of Great Britain, Germany, France, and Austria; the question as to whether a weights and measures official should be compensated by fees or salary was discussed; and the matter of drawing up a model law was referred to the executive committee. 60 pp. Price, 15 cents.

M6. Third Annual Conference on the Weights and Measures of the United States (1907).

At this conference an address was made by the Secretary of Commerce and Labor; reports were given by the various delegates on matters of interest affecting weights and measures; a paper dealing with the kinds of weights and measures fraud encountered and various sources of loss to the public was read; and proposed national and State legislation along weights and measures lines was discussed and adopted in tentative form. 110 pp. Price, 25 cents.

M7. Fourth Annual Conference on the Weights and Measures of the United States (1908).

Contains an address by the Assistant Secretary of Commerce and Labor and by the president of the conference; an opinion of the solicitor of the Department of Commerce and Labor, approved by the Attorney General, as to the extent of the authority in the weights and measures field granted to Congress under the Constitution of the United States; reports of delegates from the various States; discussion of proposed national legislation; resolutions recommending that authority be conferred upon the Bureau of Standards to pass upon all types of weighing and measuring apparatus before they be permitted in use, urging Congress to enact a law requiring containers to be marked with their net contents, and recommending other national weights and measures legislation. 78 pp. Price, 15 cents.

M8. Fifth Annual Conference on the Weights and Measures of the United States (1910).

Contains an address by the Secretary of Commerce and Labor; report of the secretary of the conference; reports of the delegates; short report on the weights and measures investigation conducted by the Bureau of Standards; paper dealing generally with the subject of weights and measures; discussion of weights and measures bills before Congress; resolutions indorsing Bureau of Standards weights and measures investigation, recommending the passage by Congress of a net-contents-of-container law, and setting forth that the high cost of living is intimately associated with weights and measures; report of committee on the formation of a full weight and measure association, and of the committee on constitution and by-laws. 123 pp. Price, 15 cents.

M9. Sixth Annual Conference on the Weights and Measures of the United States (1911).

Contains addresses by the Secretary of Commerce and Labor and the president of the conference; report of the secretary of the conference; reports of delegates; report on an investigation of the condition of weights and measures in commercial use in the United States conducted by the Bureau of Standards; paper on railroad-track scales; discussions on tolerances for weighing and measuring apparatus, legislation for uniform sizes of containers, a bill to fix sizes of certain containers, and uniform State legislation governing weights and measures; report of committee on organization of a full weight and measure league; report of the committee on State legislation; and appendix containing draft of proposed uniform law on weights and measures for adoption by the States. 158 pp. Price, 20 cents.

M10. Seventh Annual Conference on the Weights and Measures of the United States (1912).

Contains an address by the Secretary of Commerce and Labor; reports of delegates; address by the chairman of the Committee on Coinage, Weights, and Measures of the House of Representatives; report of the secretary of the conference; papers on the subjects of legislation enacted by the various States during the preceding year, method of keeping sealers' records, and platform scales; address by the State superintendent of weights and measures of New York and by the commissioner of weights and measures of New York City; discussions on the formation of a national association of weights and measures, on the net-contents-of-container law, on the changing of the date of holding the conference, and on placing weights and measures officials under civil service; reference to an inspection of weights and measures conditions throughout the United States conducted by the Bureau of Standards; review of weights and measures bills pending before Congress; report on the progress made by the committee on tolerances and specifications; resolution favoring the enactment by Congress of a law requiring all foodstuffs put up in packages to be marked in terms of standard weight or measure; answers to questions relating to the inspection of scales, double-ended measures, bottomless measures, counter tacks, wooden dishes, inspection of meters, sale of ice, sale of lard in pails, and testing scales of railroads and express companies. 186 pp. Price, 20 cents.

M11. Eighth Annual Conference on the Weights and Measures of the United States (1913).

Contains addresses by the Secretary of Commerce, the Assistant Secretary of Commerce, and the president of the conference; report by the secretary of the conference; reports by the delegates; remarks by the secretary of internal affairs of Pennsylvania; papers on the subjects of weights and measures legislation enacted by the States during the preceding year, content-of-container law, Federal regulation of weighing and measuring apparatus, testing of dry gas meters, uniformity of State laws on weights per bushel of commodities, difference in the amount of a bushel of a commodity when sold by weight and when sold by measure, testing of water meters, design and construction of scales, notes on scales, functions of a State sealer of weights and measures, testing of capacity measures, and seals and methods of sealing; discussions on proposed amendments and additions to the model State law on weights and measures, on the necessity for civil-service protection for sealers of weights and measures, on the need for inspection of scales owned by the United States, and on the place, time, and duration of sessions of the next meeting; reports of the committee on resolutions and of the committee on tolerances and specifications; resolutions indorsing a bill to establish a standard barrel, favoring the adoption of the metric carat weight, favoring civil service for weights and measures officials, and recommending that the Bureau of Standards be given authority to pass upon and authorize the use of weighing and measuring apparatus; answers to questions relating to the authority to test scales in postoffices, the weight of a gallon of milk, and the weighing of coal mined in West Virginia; and appendix containing the model State law on the subject of weights and measures. 291 pp. Price, 35 cents.

M12. Ninth Annual Conference on the Weights and Measures of the United States (1914).

Contains addresses by the Secretary of Commerce and by the president of the conference; report of the secretary of the conference; papers on the subjects of the net-weight amendment to the national food and drugs act, the metric system, creamery, prescription and jewelers' weighing and measuring appliances, glass graduates suitable for weights and measures officials, the weights and measures of Porto Rico, and the necessity of maintaining scale levers level and the lever connections plumb; announcement of an inspection and demonstration of the railroad-track scale equipment of the Bureau of Standards and of a hearing before the House Committee on Coinage, Weights, and Measures; discussions on the Tuttle-Weeks produce-barrel

bill, on tolerances and specifications, and on the place of the next meeting; reports of committee on constitution and by-laws and committees on resolutions; reports and miscellaneous papers submitted by various State and local weights and measures officials; and answers to questions relating to the size of beer barrel, proposed legislation in Virginia in relation to selling dry commodities by weight or count, and the relation of State universities to weights and measures work. 176 pp. Price, 20 cents.

M13. Tenth Annual Conference on the Weights and Measures of the United States (1915).

Contains addresses by the Secretary of Commerce and by the president of the conference; reports by delegates; report of the secretary; remarks by the collector of internal revenue of the Philippine Islands; report of railroad-track scale tests conducted by the Bureau of Standards; papers on the subjects of testing of electric meters, a method of adjusting railroad-track scales, automatic scales, weights and measures work from the standpoint of the efficiency engineer, system of keeping records, and the standard-barrel law; discussion on the Ashbrook bill; report of committee on constitution and by-laws and of committee on tolerances and specifications, and discussions thereon; resolutions relating to the appointment of a committee to investigate elevator, hopper, and grain scales, in opposition to fee system of inspection, recommending uniformity of legislation and of tolerances and specifications, for establishing a national board of examiners, inviting scale experts and manufacturers to give papers at next conference, and favoring sale of dry commodities by weight; section requiring sale of dry commodities by weight added to model law; and appendix containing the three forms of the model State law. 254 pp. Price, 50 cents.

M14. Eleventh Annual Conference on the Weights and Measures of the United States (1916).

Contains an address by the Secretary of Commerce; remarks by the president of the conference; report of the secretary; reports by the delegates; papers on the subjects of proper publicity for a weights and measures department, the selection and maintenance of apparatus in industrial plants, liquid measuring pumps, inspection and testing of track scales, installation and maintenance of track scales, recent development in heavy track-scale construction, and regulations for the weighing of coke; remarks by various manufacturers; discussion and indorsement of a bill before Congress to substitute centigrade for the Fahrenheit scale of temperature in Government publications; discussion of proper method of sale of fruits, vegetables, etc.; report of committee on tolerances and specifications and discussion thereon; reports of the committee on constitution and by-laws and of the committee on the metric system; remarks by the secretary of internal affairs of Pennsylvania; resolutions concerning the observance of a national weights and measures week, the sale of wrapped meats, the indorsement of the metric system, the appointment of a committee on public education, and the passage of Ashbrook bill; and appendix containing the specifications and tolerances for weights and measures and weighing and measuring devices, as adopted by the conference, and paper on measuring pumps. 194+44+27 pp. Price, 35 cents.

M15. Some Technical Methods of Testing Miscellaneous Supplies, Including Paints and Paint Materials, Inks, Lubricating Oils, Soaps, etc.

In this publication are assembled methods, chiefly chemical, which have been found useful in a large number of cases in testing miscellaneous materials purchased either under definite specifications or examined for prospective purchases in competition with other samples of a similar nature. As a general rule, the methods described are not original but have been compiled from a variety of sources and modifications introduced when necessary. (Nov. 15, 1916.) 68 pp. Price, 15 cents.

M16. Report to the International Committee on Electric Units and Standards.

The London conference on electric units in 1908 appointed a committee to maintain the standards and to fix the value of the Weston normal cell. The committee arranged a joint investigation of the fundamental electrical standards, which was conducted at this Bureau in 1910 by representatives of the national laboratories of England, France, Germany, and this country. Important intercomparisons were made of the resistance standards, the standard cells, and the silver voltameters of the four countries. The value finally recommended for the Weston normal cell was 1.0183 international volts at 20°C. (Jan. 1, 1912.) 207 pp. Price, 30 cents.

M17. Copper-Wire Table (English and Metric).

This card gives two abbreviated copper-wire tables, in English units on one side of the card and in metric units on the other. It is of convenient size and form for use on the desk, in the shop, etc. 1914. 2 pp. For more complete information on the electrical properties of copper see Circular No. 31. Price, 5 cents.

M18. National Bureau of Standards—Description of Work of Bureau.

Gives brief historical sketch of the Bureau; describes the various branches of its work. The paper is descriptive and general in character. This publication is now being combined with material for a new edition of Circular No. 1.

M19. Proceedings of the Second Annual Textile Conference held at the Bureau of Standards (1917).

Gives proceedings of a textile conference at the Bureau at which representatives of the industries and the Government and textile technologists were present. A series of papers on important textile problems was given by mill superintendents, scientific investigators, and technical experts, followed in each case by pertinent discussion. The program included such topics as humidity in mills, commercial grading, nomenclature, textile laboratories, methods of testing blankets, service tests, cotton and wool, classification of silks, valuation of dies, testing of Army cloth, and the like. 87 pp. Price, 20 cents.

M20. Laws Concerning the Weights and Measures of the United States (First Edition, 1904).

This work contains the weights and measures laws of the United States, of the various States, and of Alaska, the District of Columbia, Hawaii, Philippine Islands, and Porto Rico. A table giving the legal weights per bushel of commodities, as fixed by these laws, is included.

State and National Laws Concerning the Weights and Measures of the United States (Second Edition, 1912).

This work contains the weights and measures laws of the United States, of the various States, and of Alaska, the District of Columbia, Hawaii, Philippine Islands, and Porto Rico. A table giving the legal weights per bushel of commodities, as fixed by these laws, is included.

M21. Metric Manual for Soldiers.

This manual was prepared as a soldier's primer of the metric system and includes an introduction to the metric system, showing its simplicity and giving brief, clear explanation designed to avoid needless work in learning the system. Then follow sections concerning the use of the units of length, area, volume, capacity, and weight; and also a brief historical sketch, tables, a brief synopsis, and a single-page vocabulary of metric terms. (1918.) 16 pp. Price, 5 cents.

M22. Annual Report of the Director of the National Bureau of Standards for the Fiscal Year Ended June 30, 1902. 19 pp.

This and the following annual reports (M22, for 1901–2, to M33, for 1912–13, inclusive) give brief reviews of the more important completed and pending researches and other work of the Bureau, classified by Divisions, including weights and measures, heat, light, electricity, and other subjects. Financial and statistical summaries of appropriations and tests are given, as well as data concerning staff, publications, library, and similar topics.

M23. Annual Report of the Director of the National Bureau of Standards for the Fiscal Year Ended June 30, 1903.
(For abstract see M22.) 16 pp.

M24. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1904.
(For abstract see M22.) 15 pp.

M25. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1905.
(For abstract see M22.) 19 pp.

M26. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1906.
(For abstract see M22.) 19 pp.

M27. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1907.
(For abstract see M22.) 19 pp.

M28. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1908.
(For abstract see M22.) 19 pp.

M29. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1909.
(For abstract see M22.) 23 pp.

M30. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1910.
(For abstract see M22.) 19 pp.

M31. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1911.
(For abstract see M22.) 34 pp.

M32. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1912.
(For abstract see M22.) 34 pp.

M33. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1913.

(For abstract see M22.) 38 pp.

M34. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1914. 99 pp.

Beginning with the annual report for the fiscal year ended June 30, 1914, the annual report has been amplified to include more complete reference to and description of the completed and pending research and testing for the year. In addition, there has been introduced a general section at the beginning outlining the functions, organization, and location. The functions relate to standards of measurements, standard physical constants, standards of quality, standards of performance, and the relation of the Bureau's work to the public. A chart gives an analytical synopsis of the functions of the Bureau with the scope, purpose, and effect of each function. At the end are given brief summaries of the work of publications, library, correspondence, stores, personnel, appropriations, and accounts, as well as mechanical plant, construction facilities, and the care of buildings and grounds. There is a concluding section relating to recommendations.

M35. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1915.

(For abstract see M34.) 148 pp.

M36. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1916.

(For abstract see M34.) 165 pp.

M37. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1917.

(For abstract see M34.) 158 pp.

M38. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1918.

(For abstract see M34.) 206 pp.

M39. Household Weights and Measures. (Card.)

Weights and measures information most useful in the household and particularly about the kitchen is given upon the two sides of a card, which is designed to be hung in the kitchen. Most of this information is in tabular form and includes tables of common kitchen measures, liquid measure, dry measure, avoirdupois weight, weight of dry commodities most frequently used in the kitchen, etc. The most frequently used rules of mensuration are also given. 2 pp. Price, 5 cents.

M40. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1919.

(For abstract see M34.) 293 pp.

M41. Report of the Twelfth Annual Conference on Weights and Measures. (1919.)

This publication is a verbatim report of the proceedings of this conference, which is a body composed of State and local officials enforcing weights and measures inspection laws in various jurisdictions throughout the country. Many papers and discussions on topics of interest are included, one of the most important of these being the condition and proper method of regulation of liquid-measuring pumps used in dispensing gasoline, oils, etc., together with a set of specifications and tolerances tentatively adopted for this class of apparatus. The action of this conference in establishing specifications and tolerances is ordinarily followed by their official promulgation in a large number of States. Resolutions expressing the opinion of the conference on various subjects of interest are also included. 226 pp. Price, 20 cents.

M42. Progress Report of the National Screw Thread Commission.

The report submitted herewith contains the findings and recommendations of the National Screw Thread Commission, a body appointed in accordance with an Act of Congress (H. R. 10852), approved July 18, 1918. The report contains standards for screw threads, ascertained and established by the Commission in accordance with the law. It has been approved by the Commission and by the Secretary of War, the Secretary of the Navy, and the Secretary of Commerce. (Jan. 4, 1921.) 109 pp. Price, 15 cents.

M43. Thirteenth Annual Conference on the Weights and Measures of the United States. (May 24–27, 1920.)

This is a verbatim report of the proceedings of this Conference. It contains addresses by the Secretary of Commerce and by the president of the Conference; reports of delegates representing various States as to conditions in their jurisdictions; papers on the subject of gasoline pumps from the standpoint of safety, net weight, the weight standardization of bread, the standardization of containers for foodstuffs, weights and measures education in the schools, and machine measurements for dry goods; and the resolutions adopted by the Conference. The report of the committee on specifications and tolerances which was devoted to the subject of liquid-measuring devices is given as well as the discussion concerning the various provisions. The appendix consists of the complete specifications and tolerances adopted for this class of apparatus. (1921.) 200 pp. Price, 20 cents.

M44. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1920.

(For abstract see M34.) 281 pp.

M45. Buying Commodities by Weight or Measure.

The material in this publication is a reprint from Circular No. 55. All the information in that Circular especially of use in the purchase of ordinary commodities has been included here. The publication explains the Bureau's interest in this subject and gives briefly some of the results of the investigation made by the Bureau upon commercial weights and measures throughout the United States. The best methods of buying commodities and of checking the purchases made are detailed, and in this connection apparatus comprising satisfactory household test sets and their use in determining whether or not full weight and measure is being received are described. Abstracts of some useful Federal and State laws are given. One section is devoted to kitchen measuring appliances and capacity units employed. The appendix contains various tables of weights and measures. (Dec. 9, 1920.) 42 pp. Price, 10 cents.

M46. War Work of the Bureau of Standards.

Contains brief descriptions of the investigations and tests conducted by the Bureau during the war and which were of service to the military departments. Photographs illustrating the apparatus used are given in some cases. As no attempt has been made to cover each subject completely, it is advised that the various publications issued in connection with different investigations be consulted for more complete data on any particular line of work. (Apr. 1, 1921.) 299 pp. Price, 70 cents.

M47. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1921.

(For abstract see M34.) 273 pp.

M48. Fourteenth Annual Conference on the Weights and Measures of the United States. (May 23 to 26, 1921.)

This publication, a verbatim report of this Conference, contains addresses by the Secretary of Commerce, the president of the Conference, and others. Among the more important features are several papers on proper legislation concerning the sale of bread and a general discussion of this subject, all of which sets forth the view points of the industry and the weights and measures officials. A model standard loaf bread law was adopted and the text of this is contained in an appendix. Other papers and discussions are on subjects such as liquid-measuring devices, mine scales, enforcement of law, railroad weighing of coal, education of public. The reports of state delegates and resolutions are included. Specifications and tolerances for liquid-measuring devices, as amended, are contained in an appendix. (Jan. 12, 1922) 132 pp. Price, 20 cents.

M49. Graphic Comparison of Screw Thread Pitches.

A graphic chart is given showing the number of threads per inch and pitch in millimeters for both inch and millimeter systems. A simple method permits finding the nearest equivalent of one system in terms of the other. A table is printed with the chart from which values may be given more closely than can be shown in the chart and for those who prefer to use a tabulated statement. 1 p. Price, 5 cents.

M50. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1922.

In addition to the statement contained under M34, it should be stated that the present report emphasizes particularly the relation of the Bureau of Standards to the industries of the country. During the fiscal year covered by this report particular effort was made to solve such industrial problems as the elimination of unnecessary waste, the simplification of sizes, and the application of the results of research work to the practical problems of manufacturing. The work of two new divisions is described for the first time in this report; that is, the division of building and housing and the division of simplified practice. 298 pp.

M51. Fifteenth Annual Conference on the Weights and Measures of the United States. (May 23 to 26, 1922.)

Contains: addresses by the Secretary of Commerce; the chairman, Committee on Coinage, Weights, and Measures, House of Representatives; and the president of the conference; papers and discussions on subjects such as method of test of gasoline-measuring, linear-measuring, and leather-measuring devices, a uniform ton for coal, standard weight bread, the elimination of dry measures from commercial use, protection of highways by means of portable weighing devices, equipment for testing heavy-capacity scales, wholesale deliveries of gasoline especially by vehicle tanks, Federal and State approval of type of apparatus, relationship between officials and merchants and manufacturers, and manufacture of precision standards. Reports were made on the accuracy of and tolerances for heavy-duty automatic scales, and tolerances for bread and for linear-measuring devices, the latter being tentatively adopted. 148 pp. Price, 15 cents.

M52. Mollier Chart of Properties of Ammonia.

This chart presents, in graphic form, a complete table of the thermodynamic properties of ammonia, over the range of temperature and pressure useful in refrigerating engineering. It provides a rapid and convenient means for the solution of practical problems, and its accuracy is ample for this purpose. The chart itself is about 9 inches high by 23 inches wide. 1 p. Price, 5 cents.

M53. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1923.

The arrangement of this report differs from previous annual reports. The first portion deals with the functions and organization of the bureau and its relations to the Government, to the industries, and to the public. Some of the more important lines of work carried out during the year are briefly mentioned.

Detailed reports of the work of the various divisions are given as heretofore, the names of those in charge of organization units and investigations being added. At the beginning of each division's report there is given a summary of the functions, expenditures, staff, publications issued, etc. These summaries are immediately followed by a work chart giving the status of all tests and researches on June 30, 1923.

During the year 100 conferences were held between the bureau and representatives of American industries; 19 research associates were maintained in the bureau by industrial associations and manufacturers; approximately 127,000 tests were made; and 91 new publications were issued. The funds received during the year (including funds transferred from other departments) totaled $1,719,156.92. The bureau staff comprised 896 employees.

On December 31, 1922, Dr. S. W. Stratton, Director of the Bureau of Standards since its establishment in 1901, resigned. Dr. George K. Burgess, formerly chief of the metallurgical division, was appointed as his successor. 346 pp.

M54. A Standard State Zoning Enabling Act.

(Reissued as BH5, to which reference is made for abstract.)

M55. Sixteenth Annual Conference on the Weights and Measures of the United States. (May 21 to 24, 1923.)

Contains addresses by the Secretary of Commerce, the president of the conference, and the Director of the Bureau of Standards; papers and discussions on such subjects as sale of service on the basis of weight and measure, cooperation between departments, the organization and conduct of departments of weights and measures, commercial filling of, uniform regulations for, and proposed method for testing milk and cream bottles, temperature as a factor in measurement of gasoline, problems arising in the supervision of public markets, the elimination of sales by gross weight, the abolition of bushel weights, standardization and simplification, bread weight legislation and labeling requirements, origin and destination weighing of coal in carload lots, and retail sale of coal and coke. Reports were made on specifications and tolerances for vehicle tanks and fabric-measuring devices, and tolerances for heavy duty automatic scales. 153 pp. Price, 30 cents.

M56. Tables and Graphs for Facilitating the Computation of Spectral Energy Distribution by Planck's Formula.

Very frequently it has been necessary to compute the spectral energy distribution of a "black body" at some particular temperature from Planck's formula. Such computation consumes much time and labor; consequently, certain short cuts in the way of tables and graphs have been devised. Table 1 consists of relative energy values corresponding to the products wave length times temperature. Tables 2a and 2b consist of relative energy values corresponding to 33 wave lengths in the visible spectrum, at 38 different temperatures. The graphs consist of a series of isochromatics, from which the energy values can be read directly for the 33 wave lengths to an accuracy of 0.33 per cent for any temperature within the range 1,000 to 28,000° K. Sheets 1 to 7. Price, 35 cents.

M57. Large Mollier Chart.

This chart presents in graphic form a complete table in the foot-pound-Fahrenheit system of the thermodynamic properties of ammonia, over the range of temperature and pressure useful in refrigerating engineering. It provides a rapid and convenient means for the solution of practical problems. The chart itself is about 16 inches high by 40 inches wide. It is identical, except for its larger size, with the chart already published as part of C142 and separately as M52. The larger chart will serve in those cases where either higher accuracy or reduced eyestrain is sought. Price, 10 cents.

M58. Technical Conference of State Utility Commission Engineers.

This conference report gives a condensed record of the proceedings of the first annual conference of public utility commission engineers held at Washington, D. C., March 2 and 3, 1923. The report contains brief descriptions of the public utility investigations under way at the Bureau of Standards by members of the bureau's staff, papers on the grading of utility service, heating value standards for manufactured gas, and on the conservation of natural gas presented by commission engineers, a paper on grounding of electrical circuits and a review of the inductive interference situation by engineers of the bureau. In addition to the formal papers the report contains abstracts of the discussions of the papers presented to the conference. 80 pp. Price, 15 cents.

M59. Seventeenth Annual Conference on the Weights and Measures of the United States. (May 26 to 29, 1924.)

Contains addresses by the Secretary of Commerce and the president of the conference; papers and discussions on subjects such as maintenance of accuracy of scales in creameries, administration of weights and measures in Porto Rico, New Jersey sale by weight law, Indiana bread law, Federal bread bill, recent decision of United States Supreme Court on Nebraska bread law, interstate status of package goods, scientific enforcement of law, elimination of short weight and measure, international bureau of weights and measures, uniformity of regulations for milk bottles, publicity, fraudulent marking of jewelry, calibration of vehicle tanks, the retail merchant, and methods of test of taximeters in various jurisdictions. Specifications and tolerances for fabric-measuring devices were finally adopted, certain changes were made in the codes of specifications and tolerances now in effect, and further steps were taken toward the development of specifications and tolerances for vehicle tanks. 147 pp. Price, 35 cents.

M60. Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year Ended June 30, 1924.

(For abstract see M22.) 38 pp. Price, 10 cents.

M61. 1924 Report of the National Screw Thread Commission.

The 1924 report of the National Screw Thread Commission is a revision of the Progress Report published in 1921, M42, Bureau of Standards. The report has been completely revised and several new sections have been added. 176 pp. Price, 35 cents.

M62. Table of Brinell Hardness Numbers.

Increasing use of the Brinell indentation hardness test has created a need for a convenient table for converting the diameter of Brinell impressions into Brinell hardness numbers. The table gives both 3,000 kg B. H. N. for diameters of impressions between 2.00 and 6.99 mm by steps of 0.01 mm. (Dec. 17, 1924.) Card. Price, 5 cents.

M63. Report of Board of Visitors to Bureau of Standards of the Department of Commerce for the Secretary of Commerce.

The 1923 report of the visiting committee on an examination and consideration of the work of the Bureau of Standards deals with the functions and achievements of the bureau. Its economic value is illustrated by several cited cases: $15,000,000 from the bureau's brake-lining investigation, $28,000,000 total to date from the research standardization for the hosiery industry, $40,000,000 annually from the tire investigations, and $100,000,000 annually from the motor-fuel investigations and standards. The report commends the proposal to acquire for the bureau a central power plant and a suitable housing for the bureau's master scale. 14 pp. Price, 5 cents.

M64. The Standard Weights and Measures of the United States.

This is a reprint of the text of Scientific Paper No. 17, a brief description of the standards of length and mass accepted at different periods by the United States Government, to which have been added a Foreword and 17 pages of illustrations. 41 pp. Price, 15 cents.

SUBJECT INDEX OF ALL PUBLICATIONS OF THE BUREAU OF STANDARDS

(From its establishment, March 3, 1901, to June 30, 1925)

Since this is the only alphabetical index of the published work of the Bureau of Standards, the *cross references* have been made fairly complete. Topics *subordinate* to the main theme of a paper are also included if treated fully enough to justify citation. For example, under "Chronograph" will be found a reference to S65, the primary subject of which is the ratio of units. To index all such related terms, however, would make the index too long.

In using this index the reader should first look up a subject under the most specific term, for example, "Inductance" rather than "Measuring inductance." At best the indexing under general terms is necessarily incomplete.

The reader should further consult not only the *key words* of his topic but also their synonyms and antonyms, and related terms. For example, "Opacity" may be the primary topic of a study and the index would give pertinent references. "Transmission" and "Absorption," however, should also be referred to for additional citations. A more detailed list of the topics treated in the separate papers is given in the table of contents which precedes the text of each separate publication.

In addition to consulting the index to Circular 24, given below, the reader should consult also the supplemental index at the end of the current Supplementary List of Publications of the Bureau of Standards. These two indexes together form a comprehensive index of data and results of the bureau's published work. In other words, the index in the supplement brings the main index up to date.

A

Aberration, spherical, of thin lenses, S461.
Aberrations, axial, of lenses, S311.
  optical systems, C27.
  photographic lenses, S494.
Absolute electrodynamometer, S27, S28, S56.
  electromotive force of standard cells, S27.
  international ampere, S171.
  measurement, capacity, S10.
    electric quantity, S139.
    inductance, S9.
    resistance, S111.
  reflectometer, S391.
  standards of inductance, S29.
  thermopile, S261.
  value, standards of radiation, S227.
  viscosity by short-tube viscosimeters, T100.
Absorption bands, radiometric investigation, S168.
  constants of quartz, S237.
    dielectric, of antennas, S269.
    dyes by colloids in clays, T23.
  glass, C164.
  sand-lime brick, T276.
  spectra, S45, S490.
  radio waves, S476.
  tests, brick, T111.
    marble, T123.
    tile, T120.
  see also Opacity, Reflection, and Transmission.
Absorptive properties of Portland cement mortars and concretes, T3.
Accelerator in hardening Portland cement, T174.
Accidents, elevator, statistics, T202.
Accumulator, *see* Storage battery.
Accuracy, polarimetric, S35.
Acetylene, colorimetric determination, S267.
  flame, emissivity, S191.
    selective radiation, S156.
    spectrum, S362.
    visible spectrum, S279.
  radiation constant, S105.
Acid, battery, nitrates and nitrites in, T149.
  separators, T271.
  benzoic, acidimetric standard, C25, S183.
  Bessemer steels, S346.
  chloroplatinic, S82.
  sulphocyanic, S54.
Acid-resisting alloys of nickel, C100.
Acidimetric standard, benzoic acid, C25, S183.
Acidimetry, S183, C40.
  indicators, S178.
  sodium oxalate as standard, C25.
Acidity of oils, T223.
Acoustic quality, and phase of harmonics, S127.
Act, a standard state zoning enabling, BH5.
  lime-barrel, enforcement, C64.
Actinic glass, C164.
Actinoelectrical, properties of molybdenite, S486.
Action of alkali on concrete, T214.
  photographic, of charred paper, S454.
Adoption of electrical units, S102.
Adjustable sensibility of polariscope, S86, S98.
Adjustment, railroad-track scales, M13.
*Adjustment, Thomson bridge for alternating current, S181.
Aerials, antenna and coil, S354.
  see also Antenna.
Aerodynamical physics, *see* Reports, annual, of the director.
Aeronautic instruments, T237.
Aeronautical instruments, *see* Reports, annual, of the director.
Aging of duralumin, S347.
Air, action upon lubricating oils, S153.
  analyzer for determining fineness of cement, T48.
  condensers, S10.
  flow meters, T183.
  forces on circular cylinders with reference to dynamical similarity, S394.
  liquefaction, S123.
  refractive index, S327.
Air-core transformer, S449.
Aircraft, use of radio direction finding, S353.

*For more specific reference see table of contents of the publication cited.

Aircraft-engine radiators, T211.
instruments, T237.
Air flow, a hot-wire anemometer for measuring, T287.
in radiators, T211.
pump, reciprocating, rate of exhaustion by, T224.
Air fuel mixtures, dew points of, S500.
pillows, rubber, C252.
Airplane antenna constants, S341.
landing signals, radio, S431.
struts, T258.
Air-speed indicators, T237.
Airships, T270.
Alcohol, bibliography, S197.
ethyl, S197.
preparation of samples, S197.
Alkali soils, cement tile durability, T214.
concrete durability, T214.
effect upon cement drain tile and concrete, T44, T95.
water, effect upon cements, T12.
spectra, S505.
Alloy, iron carbon, critical ranges, S484.
steels at high temperatures, T205.
containing rare elements, T207.
transformations, S335.
Alloys, aluminum, copper, and magnesium, S337.
magnesium, properties, T132.
magnesium, and zinc, S363.
properties, T132, C76.
tests and heat treatment, T139.
bearing, white metal, T188.
determination of iridium in, S483.
copper, thermal expansion, S410.
iron-carbon, magnetic properties of, S463.
pure iron with carbon and manganese, S453.
magnetic, S38.
nickel, C100.
platinum, S483.
preparation of, S483.
pure iron and iron carbon, S266.
Alpha alloys etching reagents, S435.
brass, thermal expansion, S321.
Alternating current detector, S22.
galvanometer, S134, S297, S370.
measurements, S297
plate supply, electron tube generators, S381.
resistance and inductance of conductors, S374.
resistance coils, S177.
resistance and inductance of solenoids, S472.
supply, S450.
theory of regeneration, S487.
waves, S203.
currents in measuring inductance, S14.
stress tests, T275.
Altimeters, T237.
and barometers, testing of, C46.
Aluminum and its alloys, thermal expansion, S497.
alloys, mechanical and anti-corrosive properties, T132.
with magnesium and zinc, S363.
and its light alloys, properties, C76.
arc spectrum, S411.
castings, tests, T139.
constitution and metallography, S337.
determination as oxide, S286.
reflection, S45.
solders for, C78.
standard samples, C66.
thermal expansion, S426.
copper alloys, thermal expansion, S497.
melting point standard, C25.
manganese alloys, thermal expansion, S497.
copper alloys, thermal expansion, S497.
rectifiers, T265.
silicon alloys, thermal expansion, S497.
copper alloys, thermal expansion, S497.
manganese alloys, thermal expansion, S497.
zinc alloys, thermal expansion, S497.
Amateur, effect of fading on reception by, S476.
radio licenses, C122.
receiving set, C133.
wave fading, S476.
*Amendment, net weight, to food and drugs act, M12, M41.
American ball clays, T227.
bond clays, properties, T144.
marine standards committee, organization of, RX.
petroleum oils, density and thermal expansion, T77.
switchboard voltmeters and ammeters, S163.
Ammeters, C20.
high-frequency, S206.
parallel wire, C74.
switchboard, S163.
Ammonia, S501.
absorption refrigeration machines, T180.
chart of properties of, M57.
composition, purification, and certain constants, S465.
from beet sugar waste water, C145.
Mollier chart, M52.
specific volume of saturated vapor, S467.
tables and Mollier chart of thermodynamic properties of, C142.
determination in illuminating gas, T34.
latent heat of vaporization, S315.
liquid, latent heat of pressure variation, S314.
specific heat, S313.
specific heat of saturated vapor, S315.
specific volume, S420.
vapor, 501.
pressure, S369.
Ammonium persulphate for etching iron and steel, S402.
Ammunition, testing by copper cylinders, T185.
Ampere, international, S171.
Amplification by means of electron tube, C74.
Amplifier, audio-frequency, C141.
electron tube, C141.
use in potential measurements, S504.
use of electron tube as, C74.
Amplifiers, repeating, C112.
Analysis, alternating-current waves, S203.
emf waves, S119.
gas, S267, S316.
by interferometer, T131.
gases by thermal conductivity method, T249.
india rubber, S174.
iron, T33.
irons and steels, T118, C14.
liquid laundry soap, T273.
magnetic, of rifle-barrel steel, S343.
printing inks, T39.
spectrographic, S444.
volumetric, C25.
standard samples of iron and manganese ores, C26.
steels, T24, T33, T118, C14.
thermal, S213.
inverse-rate method, S336.
modified Rosenhain furnace, S348.
titanium pigment, C163.
volumetric, C40.
water, turbidity standard, S367.
Analyzed samples, C25.
See also Standard samples.
Analyzer, air, for determining fineness of cement. T48.
Anderson's method of measuring inductance, S14.
Anemometer, hot-wire, for measuring air flow, T287.
Aneroid barometers and altimeters, testing of, C46.
calorimeter, S247, S301.
calorimetry, S248, S313, S314, S315.
Angle of wave front, S354.
Angles, T218.
Annealed carbon steels, grain size, S397.
eutectoid carbon steel, S408.
Annealing cast bronze, T60.
glass, S358.
thermometers, S32.
white cast iron, T129.
Annual conferences on weights and measures, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M41, M43, M48, M51, M55, M59.
reports of Director of Bureau of Standards, M22, M23, M24, M25, M26, M27, M28, M29, M30, M31, M32, M33, M34, M35, M36, M37, M38, M40, M44, M47, M50, M60.

*For more specific reference see table of contents of the publication cited.

Antenna aerials, S354.
airplane, directive receiving properties of, S480.
capacity, S326.
coil, S431.
double coil, directional transmission, characteristics of, S480.
loop, transmitting, S480.
Antennas, S354, C74.
airplane, constants of, S341.
coil, S428.
transmission from, S431.
effect of distributed reactance, S126, C74.
effective height, S159, S226, C74.
electrical oscillations, S157, S326.
natural wave length, S326.
oscillations, S157, S326.
radiotelegraphic, S257, S269.
resistance, S189, S257, S269, S341, C74.
shape, effect, S159, C74.
Antimony, arc spectrum, S411.
photoelectrical properties of sulphide of, S322, S398, S462.
reflecting power, S152.
spectral classifications, critical potentials, and absorption spectra, S490.
Apparatus for determining magnetic wave form, S87.
for high-temperature tensile tests, T219.
for testing dry cells and batteries, T171.
for testing brick, T251.
glass volumetric, S92.
Apparel standards, C149.
A. P. I. scale for petroleum oil hydrometers, C154.
Appliances for household use of natural gas, C116.
Application of national electrical safety code, C72.
Applications of interferometer, S485.
Apple barrel law, M1.
Approval-of-type legislation, M51.
Aprons, surgeons' rubber, C247.
Arc, electric, oscillations from, S60.
fused steel, T179.
high-frequency, S60, S226, C74.
lamp cadmium vapor, S371.
mercury, S128.
oscillations from electric, S60.
spectra, S466.
of neodymium, S442.
of the platinum metals, S499.
samarium, S442.
seven elements, S372.
wave lengths, S411.
yttrium, lanthanum, and cerium, S421.
spectrum of molybdenum, S474.
temperature, S8.
Architectural acoustics, S506.
Arts in gases and vapors, S425.
iron, cobalt, and nickel, spectra, S324.
low-voltage, for metals of second group of periodic table, S403.
in caesium vapor, S386.
searchlight, high-intensity, T168.
Area, contact, on ball and roller bearings, T201.
measurement of leather, T153.
measurements, C2.
Argentite, S446.
Argon lines, intensity, S146.
spectrum, S414.
Arguments, large, functions for, S100.
Arithmetical mean distances, formulas, S169.
mean distances, tables, S169.
Army duck, C166.
Arsenic, spectral classifications, critical potentials, and absorption spectra, S490.
Artificial illuminants, daylight efficiency of, S125.
Asbestos, compressed, sheet packing, C241.
high-pressure rod packing, C238.
metallic cloth gaskets, C242.
metallic cloth sheet packing, C243.
paper and asbestos millboard, simplified practice in, R19.
Ascophyllum nodusum, fucose from, S459.
Asphalt, C159, C160, C168, R4.
primer, C162.
specification for, C192.
varnish, specification, C104.
Atmosphere, relative spectral transmission, S389.
Atmospheric absorption, S262.
conditions, influence in testing sugars, S221.
electricity, relation to radio transmission, S476.
gas burners, T193.
Atmospherics, relation to radio reception, S476.
Atomic theory, S386.
weight, bromide, S193.
chlorine, S81.
hydrogen, S77.
Attachment, photometric, for spectroscopes, S155.
Atterberg plasticity method, T46.
Audibility meter, C74.
Audio-frequency amplification, S449, S450.
Austenite, S356.
Austin's formula for readiographic transmission, S159, S226, C74.
Automatic apparatus for intermittent testing, T171.
scales, M13, M41, M51.
telephone system, C112.
Automobile cylinder oils, T73.
tire fabric testing, T68.
loss, T213.
Automobiles, C198.
fuel consumption affected by tires, C198, C283.
Automotive power plant, *see* Reports, annual, of the director.
"Average eye" for heterochromatic photometry, S299.
relative sensibility, S303.
Axial aberrations of lenses, S311.
Axles, foreign specifications, T61.
Ayrton-Jones absolute electrodynamometer, S56.

B

"B" battery, S450.
Babbitt metal, standards for analysis, C25.
metals, T188.
Backing for photographic plates, S409.
Bag, helmet-shaped, rubber, C228.
paper, stress strain tests, T187.
Bags, ice, rubber, C227.
politzer, rubber, C222.
Bakelite, insulating material, S352.
Balance, specific gravity, for gases, T89.
Balancing resistances, S450.
Ball bearings, friction and carrying capacity, T201.
clays, T227.
Balloon fabrics, permeability, T113.
Balloons affected by solar radiation, T128.
Bandages, rubber, C219.
Bands, oscillatory interference, S150.
Banked winding of coils, C74.
windings, inductance coils, S455.
Barium carbonate in rubber goods, T64.
Case's photo-electric cells, S462.
critical potentials S403.
fuconate, preparation of, S459.
sulphate in rubber goods, T64.
titration method for determining carbon, T33.
Barographs, T237.
Barometers and altimeters, testing of, C46.
testing, C46.
Barometric conditions, effect on radio transmission, S476.
Barrel law, Federal, C71.
standard, interpretation, M13.
standard bill, M9, M12.
Barrels, steel, and drums, R20.
Bars, steel reinforcing, R26.
uniform, for magnetic standards, S295.
Basic carbonate white lead, specifications, C84.
lead acetate, influence on optical rotation of sucrose, S52.
sulphate white lead, specifications, C85.
Basket-woven inductance coils, S455.
Baskets for berries, C61.
Batteries, dry, S364, C79.
specifications for, C139.
sulphation of plates, T225.
testing, T171.
internal resistance, S504.
storage, T149, C92.
testing, T146.
vehicle type, operation and care, C92.

*For more specific reference see table of contents of the publication cited.

Battery acid, nitrates and nitrites in, T149.
circuits, automobile, oscillations in, T186.
Battleship linoleum, C191.
Baumé hydrometer scales, C16, C19, C59.
for sugar solutions, T115.
Beacon, radio, S428.
directive, S480.
Beams, T258.
concrete, reinforced, T2, T182.
curved, T260.
Bearing alloys, white metal, T188.
Bearings, ball and roller, friction and carrying capacity, T201.
radio, variations, S353.
Beat, reception, C74.
Beater calculations, pickers, T277.
Beds, hospital, R24.
sizes, R2.
Belting, leather, C148.
Bending, slow, T289.
Benzoic acid, acidimetric standard, C25, S183.
combustion heat, S230.
standard for combustion, C25.
Berry boxes and baskets, C61.
Bessel's functions, S100.
Bessemer practice, temperature measurements, T91.
steels, acid, S346.
Beta brass, thermal expansion, S321.
Bibliography, helium, C81.
*Bill, standard barrel, M9, M12.
Bimetallic wires, inductance, iron, S252.
resistance, S252.
skin effect, S252.
Bismuth, arc spectrum, S411.
silver thermopiles, S229.
spectral classifications, critical potentials, and absorption spectra, S490.
Bismuthinite, photoelectrical sensitivity, S322.
Bituminous materials, tests, C45.
see also Reports, annual, of the director.
Bjerknes method of decrement measurement, S235, C74.
Blackboard slate, R15.
"Black body," S204, S262, S284.
radiation, S305, S357.
relation of luminosity to temperature, S270.
see also Uniformly heated inclosure.
"Black nickel" plating solutions, T190.
Black paint, specification, C94.
Black waterproof drawing ink, specification for, C196.
Blanket tests, apparatus, T266.
Blankets, bed, simplified practice in, R11.
laundering, T273.
properties, T266.
Blends, Saybolt viscosity, T164.
Blood counting instruments, S507.
Blue denim (unshrunk), C266.
(shrunk), indigo, C265.
Board, gypsum plaster, C210.
gypsum wall, C211.
of visitors, M63.
Boiler plate, T219.
plugs, fusible tin, T53.
settings, brick for, T279.
Boilers, range, simplified practice in, R8.
Boiling point, naphthaline and benzophenone, S143.
sulphur, S149, S339.
thermometric standard materials, C35.
Bolometer bridge, use in standardizations of ammeters, C74.
Bolometers, S85, S244.
vacuum, S188, S204.
Bolts, plow, R23.
Bomb calorimeters, standardizing, C11.
calorimetry, S230.
standards for, C25.
Bond clays, T79.
for brick work, T111.
resistance between concrete and steel, T173.
Books, radio, C122.
Borosilicate glazes, T31.
Bottle, cloth inserted hot-water, C249.
Bottles, rubber hot water, C248.
Bournonite, S451.
Box dimensions, T253.
Boxes for berries, C61.
hosiery, C169.
Brass containing iron, T221.
magnetic susceptibility, T221.
corrosion as affected by structure, T103.
ductility and strength, T83.
failure, T82, T83, T84.
lavatory, R21.
internal stresses, as related to structure, S321.
measured, T82.
"season cracking," T82.
thermal expansion, S321.
corrosion, standard for analysis, C25.
sink traps, R21.
tubing, internal stress in, T257, T285.
Brasses, etching characteristics, S435.
of Muntz metal type, S321.
Bread, M55, M59.
decision, U. S. Sup. Ct., on State law on, M55, M59.
Federal bill on, M55, M59.
*model law, M48.
tolerances, M51, M55, M59.
*weight standardization, M43, M48, M55, M59.
Breaking strength (grab, 1 by 1 by 3 inches), C166, C167.
of 7s yarn, T278.
Brick, T251, C150, C153.
face and common, simplified practice in, R7.
fire clay, T279.
fire, melting points, T10.
porosity and volume changes, T159.
piers, compressive strength, T111.
sand-lime, absorption of, T276
compressive strength of, T276.
description and specification, C109.
manufacture and properties, T85.
modulus of elasticity of, T276.
modulus of rupture of, T276.
silica, constitution and microstructure, T124.
transverse, compression, and absorption tests, T111.
walls, compressive strength of sand-lime, T276.
Bricks, paving, R1.
Bridge columns, tests, T101.
Bridges, Wheatstone, S241, S288.
Brightness of image found by optical instrument, C27.
of white papers, T244.
Brinell, M62.
hardness, T11.
numerals, table of, S471.
related to grain size of steels, S397.
Brittleness, intercrystalline, of copper, T158.
of lead, S377.
of malleable cast iron, T245.
Bromine, atomic weight, S193.
Bronze, cast, changes upon annealing, T60.
standard for analysis, C25.
Bronzes, etching characteristics, S435.
Brown coat, C205.
denim (shrunk), C256.
(unshrunk), C259.
Brush discharge, condenser losses, S190.
Builders' hardware, R18.
Building code committee report, special Pub.
columns, fire tests, T184.
materials, *see* Reports, annual, of the director.
tiles, hollow, tests, T120.
tiles for, T120.
units, concrete, R32.
Buildings and grounds at Bureau of Standards, *see* Reports, annual, of the director.
minimum live loads allowable for use in design of, BH7.
Built-up roofing, type 3ACS, C172.
type 4ACS, C173.
type 5ACS, C174.
type 4AWS, C170.
type 5AWS, C171.
type 3TCS, C175.
type 4TCS, C176.
type 5TCS, C177.
type 4TWS, C178.
type 5TWS, C179.
Bulletin Radio Service, C122.
Bureau of Standards, description of work, M18.
publications, C24.
see Report, annual.
standard samples, C25.
war work, M46.

*For more specific reference see table of contents of the publication cited.

Burettes, drainage of, S92.
glass, C9.
Burned clay, porosity and specific gravity, T22.
Burners, gas, design, T193.
"Burning in" manganese bronze, T84.
Burning clay products, T17, T21, T22.
silica refractories, T116.
tiles, T120.
temperatures of porcelain determined by microscopic examination, T80.
Burnings, repeated, of silica brick at high temperatures, T124.
Bushel, heaped, C10.
stricken, C10.
weights, C10, M11.
Butter color, T92.
Butterworth, inductance formulas, S455.
Buying commodities by weight or measure, M45, C55.
Buzzer source of radio-frequency current, S95.
Buzzers, C74.
By-product recovery from beet-sugar waste water, C145.

C

Cable, electric, terminology, C37.
Cadmium, arc spectrum, S411.
critical potentials, S403.
electrode for storage battery testing, T146.
reflection, S45.
spectrum wave lengths, S441.
vapor, S317.
arc lamp, S371.
Caesium vapor, low-voltage arcs, S386.
Cafeteria and restaurant chinaware, R33.
Cal as an accelerator in hardening Portland cement, T174.
Calcined, C206.
Calcium, C152, C153.
aluminate in Portland cement, T78.
aluminates, cementing qualities, T197.
arsenate, recommended specification for quicklime and hydrated lime for use in the manufacture of, C203.
chloride solutions, specific heat, S135.
critical potentials, S403.
evacuator, S244.
silicate in Portland cement, T78.
sulphate, C205.
vapors, electrons in, S368.
Calculation, inductance, S93, S169, S320, S495, C74.
radiation constants, S284.
self-inductance, S47, S93, S169, S320, C74.
standards of inductance, S29.
Calculations, cotton machinery, T277.
on cotton pickers, T282.
Calibration, gas interferometer, S316.
pyrometers, C7.
viscometers, S298.
Calipers, C2.
Callendar radiobalance, S188.
Call letters, radio, C122.
Calorimeter, S503.
tables, gas, C65.
Calorimeters, aneroid, S247, S301.
bomb, standardizing, C11.
gas, operation of, C48.
vacuum-jacketed, S231.
Calorimetric resistance thermometers, S68, S200.
Calorimetry, S501.
aneroid, S248, S313, S314, S315.
bomb, S230.
combustion, S230.
electrical, S209.
flow, S135, T36.
industrial, gas, T36.
method of mixtures, S209.
Camera, T255.
Canal rays, S23.
Candlepower, T110, C15.
mean spherical, measurement by sphere, S447.
of lamps, S253.
scale for precision photometers, S144.
unit, S50
Cane sugar, combustion heat, S230.
standard, C25.
Capacities between elements of electron tubes, S351.
effect of stray, on high-frequency measurements, C74.
Capacitive coupling, C74.
Capacity, absolute measurement, S10.
and density, *see* Reports, annual, of the director.
and inductance, distributed, in secondary coupled circuit, S126.
antenna, S326.
antennas, formulas, C74.
condenser, S64.
distributed between inductance coils and ground, S427.
electrical, S29, S427, C74.
absolute measurement, S10.
coupled circuits, S126.
determination, S65, C74.
distributed, *see* Reactance, distributed.
inductance coil, S126, S175, S326.
mica condensers as standards, S137.
measurement, by Anderson's bridge, S14.
paper condenser, S166.
power factor of condensers, measurement, S64.
standards, S17, S137, C4.
test fees, C4.
units of definitions and tables of equivalents, C47, M2.
glass vessels, tables for determining by water weights, C19.
measures, commercial, specifications and tolerance, C61, M1.
*testing, C4, M1, M11.
of inductance coils, S430.
polygonal inductance coils, S468.
Capillary electrometer with alternating voltages, S90.
thermometer, S170.
Caps, milk bottle, simplified practice in, R10.
Car wheels, steel, thermal stresses in, T235.
thermal stresses, T209.
Carat, metric, C43.
Carbon content, effect of, on magnetic properties of iron-carbon alloys, S463.
effects on pure iron, S453.
monoxide from natural gas burners, T212.
in products of combustion, T222.
steels at high temperatures, T219.
tetrachloride base for fire extinguishers, C134.
determination by electrolytic resistance method, T141.
in steel and iron, T33.
dioxide, analysis by thermal conductivity method, T249.
in steels, T126.
in rubber goods, T136.
in steels and irons, T69.
lamps, photometry, S115.
monoxide in steels, T126.
paper, C95.
radiation constant, S105.
resistor, T247.
selective radiation, S131.
steel, T267.
annealed, grain size of, S397.
eutectoid, magnetic properties, S408.
hardened changes upon heating, S396.
mechanical properties, T206.
use in reclamation of gasoline, T280.
Carbonate, C152.
Carbonating apparatus, S432.
Carbonic acid tests of marble, T123.
Carbonization, lubricating oils, C99.
mineral lubricating oils, T4.
Carborundum, reflection, S45.
Cardboard boxes, T253.
Care of vehicle-type batteries, C92.
Cartridge-bag cloth, T268.
yarn, T268.
Cartridge-inclosed fuses, T74.
Cast bronze, changes upon annealing, T60.
standard, for analysis, C25.
red brass containing iron, T221.
iron enameled wares, T142.
malleable, embrittlement of, T245.
heat treatment to reduce brittleness, T245.
parts for locomotive cylinders, T172.
white, graphitized upon annealing, T129.
wet process enameling of, T246.
Casting, C206.
clays aided by sodium salts, T51.
glass pots, T144.
Catalog, radio subjects, C138.

*For more specific reference see table of contents of the publication cited.

Catheters, rubber, C225.
Cathode-ray oscillograph for frequency standardization, S489.
Cattle field fence, R9.
Causes for rejection of duck, C136.
Causticizing, quicklime, for use in C143.
Cell, Clark standard, S390.
photoelectric, S319.
standard, voltage of, S220.
Weston standard, S104.
Cells, concentration, thermodynamics of, S165.
dry, T171.
voltage, S364.
electrical characteristics and testing, C79.
electromotive force of, S434.
standard, S27, S67, S70, S71, S102, M16.
storage, T146, C92.
Cellular tiles, T120.
windings, inductance coils, S455.
Celluloid, S193, T98.
as affected by heat, T98.
Cellulose, S195, T88.
content in rubber goods, T154.
sulphite, extract, T215.
Cement, T239, C151.
acted upon by salts in sea and alkali water, T12.
bags of paper, T187.
brick, T251.
caustic magnesia, C135.
drain tile and concrete in alkali soils, T44, T95.
fineness determined by air analyzer, T48.
for spark-plug electrodes, T155.
Portland, Government specification, C33.
hardened with Cal, T174.
hydration, T43.
properties, T102.
steam test, T47.
sieves, standard, T29.
standardization, T42.
standards for testing sieves, C25.
tests, C45.
see also Reports, annual, of the director.
tile durability in alkali soils, T214.
Cementing qualities of calcium aluminates, T196.
"Center of gravity" of transmission of pyrometer color screens S260.
Centrifugally cast steel, T192.
Ceramic kilns, temperature measurement, T40.
Ceramics, S485, C152.
see Reports, annual, of the director.
Cerium, arc spectrum, S421.
Changes in complicated group of objects, S392.
thermal and physical, upon heating hardened carbon steels, S396.
Characteristics, electrical, of dry cells, C79.
electron tubes, S351.
tube generators, S355.
glass, S358.
molybdenite, selenium, and stibnite, S398.
of American plates and films, S439.
Charges carried by canal rays, S23.
Charred records, deciphering, S454.
Chart, metric, M3.
Cheesecloth, bleached, C257.
wiping, C255.
semibleached, C257.
unbleached, C258.
Chemical, C150, C152.
elements, melting points, C35.
glassware, tests, T107.
metallurgy, *see* Reports, annual, of the director.
porcelain glazes, T196.
tests of commercial marbles, T123.
Chemical properties of electrical insulating materials, T216.
Chemicals, tests, C45.
Chemistry, *see* Reports, annual, of the director.
Children's hosiery boxes, T253.
Chinaware, cafeteria and restaurant, R33.
hotel, simplified practice in, R5.
methods, for testing C202.
specifications for Government services, lunch counters, hospitals, hotels, restaurants, C202.
Chipped glass, C164.
Chlorine, atomic weight, S81.
Chloroplatinic acid prepared by electrolysis of platinum, S82.
Chrome-vanadium steels, S161.
standard for analysis, C25.
Chromium, *see* Ferrochromium, S448.
arc, spectrum S372.
determination in steels, T6.
reflecting power, S152.
steel, thermal characteristics, S335.
Chronograph, S65.
recording for inverse rate, method of thermal analysis, T230.
Chronometers, C51.
Circle, mutual inductances, S56, S169.
Circles, mutual inductance of coaxial, S138, S169.
parallel coaxial, S138.
mutual inductance, S320.
self-inductance, S75, S169.
Circuits, coupled, S112, S126, S158, C74.
energy losses in high-frequency, S190.
high-frequency, coupled, S158.
low-power factor, S18.
plate, load in, S351.
radio-frequency, for measurements, S471.
Circular coaxial coils, S42.
coils, inductance, S455.
currents, coaxial, S255.
cylinders, air forces on, with reference to dynamical similarity, S394.
knit hosiery, C149.
Clark standard cell, S27, S67, S70, S390.
cracking of, S390.
Classes of fit for screw threads, M42.
Classification of waste silk, T268.
radio, C138.
Clay, brick, T251.
fire brick, T279.
porosity and volume changes, T159.
products, *see* Reports, annual, of the director.
refractories, testing, T7.
hollow tile and concrete floor slabs, tests of, C261.
tile, T120.
Clays, T262.
colloidal matter in, T23.
dehydration, T21.
drying after preliminary heat treatment, S151, T1.
effect of overfiring, T22.
fire, European, T79.
methods of measuring plasticity of, T234.
properties of, T227.
plasticity, S278.
measurement, T46.
purifying and casting aided by sodium salts, T51.
tests, C45.
time in vitrification, T17.
Clean wools, weight, T57.
Cleaning of sheet steel, T165.
Clerget divisor, S375.
Clerks' instructions, *see* Reports, annual, of the director.
Clinical thermometer comparator, S13.
Clinical thermometers, S13.
testing, C5, S13.
Close-mesh hog fence, R9.
Cloth gaskets, asbestos metallic, C242.
Cloth-inserted fountain syringe, C250.
hot-water bottle, C249.
ring cushions, C254.
Cloth insertion rubber packing, C236.
Clothing standards, C149.
Cloths for wiping purposes, C267.
*Coal, destination weighing of, M48.
Illinois, coked in Koppers type oven, T137.
orient, tests, T134.
Coating on tinned sheet copper, structure, T90.
Coatings, insulating, to prevent electrolysis, T15.
Coaxial, circles, determining mutual inductance, S492, S498.
mutual inductances, S138, S492, S498.
circular currents, S255.
coils, S41, S42.
mutual inductance, S41, S56.
rectangular section, mutual inductance, S42.
currents, force between, S255.
single-layer coil, mutual inductance, S42.
solenoids, mutual inductance, S58, S59.
Cobalt arc, spectrum, S324.

*For more specific reference see table of contents of the publication cited.

Code, safety, for head and eye protection, H2.
logging and sawmill, H5.
national electrical, H3, H4, C54, C72.
Coefficient of reflection of electrical waves, S114.
temperature, of magnetic permeability, S245.
of resistance of copper, S147.
Coercive force varying with magnetizing force, S384.
Coil aerials, S354.
antenna, S431.
transmitting, S480.
antennas, S354, S428.
any, self-inductance of, S83.
galvanometers, S297.
length of layers of wire, self-inductance, S83.
self-inductance of toroidal, S74.
toroidal, S74.
Coils, C74.
alternating, S177.
circular coaxial, rectangular section, mutual inductance, S42, S169.
apparent inductance, C74.
coaxial, S41, S42.
circular, force between, S255.
mutual inductance of, S41, S169.
dielectric absorption, C74.
electrical oscillations in inductance, S326.
high-frequency resistance, S169, S252, S374, S430, C74.
horizontal, field radiation of, S431.
inductance of, S468.
polygonal, S468.
inductance, calculation, S169.
of resistance, S175.
oscillations, S326.
influence of frequency upon self-inductance, S37, S374.
resistance, S175, S177.
and inductance of solenoidal, S76.
self-inductance of single-layer, S31, S37, S169.
single-layer alternating current, resistance and inductance of, S472.
stranded, use at high frequencies, C74.
use at high frequencies, S427, S430, C74.
solenoidal, S76.
*Coke, weighing of, M14.
Cold-junction corrections for thermocouples, S202.
Cold-rolling, cause of stresses, T163.
tests, open-hearth steel, T288.
Cold work, effect upon recrystallization of metals, T60.
Colloidal matter in clays, T23.
solutions, S195.
Colon tubes, rubber, C221.
Color differences between glass screens and tungsten lamps, S277.
match versus spectral intensity match, S156.
of hollow tiles, T120.
of illuminants, S443.
of searchlight arcs, T168.
of white papers, T244.
perception versus brightness perception, S303.
pure, natural scale of, S118.
screens, pyrometer, S260.
sensitive photographic plates, S422.
sensitiveness, S439.
system, Munsell, T167.
temperature, S443.
precision and accuracy, S443.
vision, S417.
Colored cotton waste, C263.
glass, C164.
wall plaster, T181.
waste wool, C260.
Colorimeter, precision, S187.
Colorimetric determination of acetylene, S267.
of iron, S53.
Colorimetry, S443.
see Reports, annual, of the director.
standards, C25.
Colorless waterproofing materials, T248.
Column formula, T152.
Columns, T218, T258, T263.
bridge, tests, T101.
building, fire tests, T184.
concrete, fire resistance of, T272.
reinforced concrete, tests, T122.
strength of, T152.
Combustible gas in air, instruments showing, S334.
Combustion calorimetry, S230.
method for determining rubber, T35.
standard samples, C25.
Commercial copper, electrical conductivity, S148.
marbles, physical and chemical tests, T123.
micrometers, T226.
Committee, American Marine Standards, organization of, RX.
Common battery telephone system, C112.
Comparator, Bureau of Standards, S1.
International Bureau, S1.
thermometer, S69.
Comparing American switchboard voltmeters and ammeters, S163.
plain and frosted lamps, S72.
wave lengths, S142, S179, S251, S274, S302, S329, S414.
Comparison, graphic, of screw thread pitches, M49.
lamp, tungsten, S115.
Compass, radio, S428.
Compasses, aircraft, T237.
magnetic, S382.
Compensated two-circuit electrodynamometer, S48.
Compensating polariscope, S98.
quartz polariscope, S86.
Compensation, radio direction finders, S353.
Complementary of light from mercury arc, S128.
Composite thinner for semipaste paints, C102.
vehicle, comments on, T274.
Composition flooring, C135.
purification and certain constants of ammonia, S465.
inks, C95.
printing inks, C53.
Compound, rust-preventive, C200.
Compounds, rust-preventive, medium and light, C214.
Compressed air condenser, S190.
asbestos sheet packing, C241.
Compression tests, T218.
brick, T111.
tiles, T120.
Compressive strength, brick piers, T111.
of columns, T263.
of mortar specimens, T276.
of sand-lime brick, T276.
wallettes, T276.
walls, T276.
of tiles, T120.
rectangular spruce struts, T152.
Computing and recording machine ribbons, specification for, C188.
characteristics of tungsten lamps, S253.
Planck's constant, S162.
radiation data, S360.
Concentration cells, S165.
Concrete, R4.
acted upon by salts in sea and alkali water, T12.
and steel bond resistance, T173.
beams, double-reinforced, T182.
reinforced, T2.
block tests, T214.
durability in alkali soils, T214.
slab beams reinforced diagonally, T233.
building units, R32.
columns, T184.
reinforced with cast iron, T122.
electrolysis in, T18.
fire resistance of, T130, T272.
in alkali soils, T95.
Portland cement, T3, T5.
pouring and pressure tests, T175.
properties as affected by materials and methods of preparation, T58.
see also Reports, annual, of the director.
Condensation of gasoline vapor, *see* Dew points, S500.
Condenser plates, exponential shape, S235.
type antenna, S354.
series-antenna, C137.
telephone-shunt, C137.
Condensers, air, C74.
capacity and power factor measurements, S64.
cylindrical, S65.
electrical, S10, S65, C36.
mica, as standards of capacity, S137.
of low power factor, S18, S64.

*For more specific reference see table of contents of the publication cited.

Condensers—Continued.
paraffined paper, S166.
standard variable air, C74.
used in high-frequency circuits, S190.
Conducting gases, S6.
Conduction, electrical, in metals, S307.
Conductivity, electrical, of copper, S148.
Conductor, elbows, R29.
four-terminal, S181.
pipe, R29.
Conductors, H3.
linear, inductance of, S80.
resistance and inductance, S374.
Conference on textiles, M19.
weights and measures, *see* Weights and measures conferences.
Conserving tin in alloys, T109.
Constancy of the sulphur boiling point, S149.
Constant c_2 of Planck's equation, S162, S287.
electrochemical, S271.
pressure gas thermometer, S57.
temperature still head for light-oil fractionation, T140.
Constantan, thermoelectric properties, S120.
Constants, absorption, reflection, and dispersion, of quarts, S237.
airplane antenna, S341.
ammonia at the triple point, S465.
instrument transformer, S130.
Planck's radiation equation, S304.
quartz-wedge saccharimeter, S268.
radiation from black body, S262, S284, S357, S406.
radiation, calculation, S284.
of metals, S105.
spectral radiation, S204, S284.
Constitution, aluminum and its alloys with copper and magnesium, S337.
porcelain, T80.
silica brick, T124.
Constructing platinum resistance thermometers, S407.
rail joints and bonds in electric railways, T62.
standards of inductance, S29.
stucco and plaster, durability, T70.
Construction, data, sand-lime brick walls, T276.
of radio receiving outfit, C120.
of roofing, type 3ACS, C172.
type 4ACS, C173.
type 5ACS, C174.
type 4AWS, C170.
type 5AWS, C171.
type 3TCS, C175.
type 4TCS, C176.
type 5TCS, C177.
type 4TWS, C178.
type 5TWS, C179.
simple electron-tube detector, C133.
Contact rectifiers of electric currents, S94, S140, S157, C74.
*Containers for foodstuffs, standardization, M43.
for shipment, C77.
Contrast, photographic, S430.
sensibility of the eye, S366.
Control system for electric testing laboratory, S291.
Controlling colloidal matter in clays, T23.
Converging lens, S110.
Conversion from metric to English units, C47.
tables, pounds to gallons, gallons to pounds, T9.
Cooling curves, S99, S348.
power of aircraft radiators, T211.
rate related to properties of carbon steel, S408.
Copper, C73.
alloys, etching reagents, S435.
clad steel wire, resistance, S252.
corrosion and pitting, T90.
crusher cylinders, T185.
deposition, C52.
effect on red shortness of iron, T261.
electrical conductivity, S148.
estimation of temperature, S121.
etching reagents for, S399.
impurities in, C73.
intercrystalline brittleness, T158.
mechanical properties of, C73.
metallography, C73.
microstructure, S399.
physical properties of, C73.
resistance, temperature coefficient of, S147.
Copper—Continued.
specific heat, S231.
standard for melting point, C25.
standard samples, C66.
statistics of production, price, etc., C73.
sulphate solutions, S275.
technology of, C73.
thermal expansion, S410.
thermoelectric properties, S120.
typical specifications, C73.
wire tables, C31, M17.
Copper-nickel alloys, C100.
Copper-nickel-zinc alloys (nickel silver), C100.
Correction, emergent-stem, for thermometers, S170, T49.
Corrections, cold-junction, for thermocouples, S202.
Corrosion, cement, affected by Cal, T174.
coating on tinned sheet copper, T90.
effect on ductility and strength of brass, T83.
electrolytic, influenced by varying frequencies of current, T72.
exposure of manganese bronze under tensile stress, T135.
lead, S377.
Muntz metal, T103.
of iron in soils, T25.
protecting iron and steel from, C80.
resistance of rolled light alloys, T132.
test, H2.
see also Reports, annual, of the director.
Corrugated glass, C164.
Cotton, T277.
calculations, T277.
duck, T264, C167, R27.
specification, C136.
machinery, T277.
technology of, T282.
mill, T282.
picker, T277.
pickers, calculations, T282.
Pima, T277.
rags for wiping machinery, C261.
waste, colored, C263.
white, C262.
yarn (No. 7s) mill organization, T277.
yarn properties, T278.
rubber-lined fire hose, C114.
yarns, physical testing, T19.
Cots, rubber finger, C226.
Coulometer, silver, S16.
Coupled circuits, theory, S112, S126.
high-frequency circuits, S158.
Coupling, capacitive, C74.
inductive, C74.
Couplings and fittings for fire hose, C50.
Crane, floating, strain-gage tests, T151.
*Creamery, weights and measures appliances, M12.
Creosote-oil distillation thermometers, T49.
Critical load on ball and roller bearings, T201.
ranges, A_2 and A_3 of iron, S213.
glass, S358.
iron, S326.
nickel steels, S376.
pure iron, S296.
Critically damped galvanometers, S273.
Cross talk, C112.
Crossing specification, H3, H4.
Crova wave length, S305.
Crusher cylinders, copper, T185.
Crushing strength of Portland cement mortar and concrete, T5.
Crystal detector, S94, S140, S157, S450, C74, C121.
radio outfit, C120.
Cubic-foot standard for gas, T114.
Cupric chloride, infra-red spectral transmission, S168, S191.
Cuprous oxide, spectrophoto-electrical sensitivity of, S462.
Current detector, S22.
electric, absolute measurement, S255.
rectifiers of, S94.
leakage from electric railways, T63, T75.
magnetizing, and regulation of potential transformers, S129.
measurement, S172, C74
radiofrequency, measurement, S157, S206.
sheet, inductance calculations, S169, S320.
polygonal, inductance, S468.

*For more specific reference see table of contents of the publication cited.

Current detector—Continued.
strength and intensities of some spectrum lines, S146.
transformers, S164, S309.
value oscillations in automobile battery circuits, T186.
Currents, circular, coaxial, S255.
Curves, cooling, S99.
parabolic and linear, S388.
Cushions, cloth-inserted ring, C254.
rubber ring, C246.
Customary units converted to metric units, C47.
Cutters, milling, R36.
Cutting blowpipes, oxyacetylene, T200.
fluids, T204.
Cutting tests, high-speed steels, T228.
Cyanides from beet-sugar waste water, C145.
Cylinder oils, automobile, T73.
Cylinders, circular, air forces on, S394.
crusher, copper, T185.

D

Damaged hosiery boxes, causes, T253.
Damped current, effective value, C74.
galvanometers, S273.
high-frequency electrical oscillations, S95, S140, C74.
Damping radio wave, S235.
waves in mercury, S289.
Damp proofing, asphalt for, C160.
coal tar for, C155.
materials for concrete, T3.
Dams, rubber, C218.
Data, automobile cylinder oils, T73.
electric railway track leakage, T75.
transmission, in spectrum, S418.
Daylight effect, radio transmission, S159, S226.
efficiency of artificial illuminants, S125.
"Dead spots" and radio reception, S476.
Decarburization of ferrochromium by hydrogen, S448.
Decimal classification, radio, C138.
Deciphering charred paper records, S454.
Decrease of radiation with use of quartz mercury vapor lamps, S330.
Decrement, method of resistance measurement, S189, C74.
Decremeter, S235, C74.
Definition, fundamental electrical units, S102.
gypsum trade terms, C108.
ideal gas, S136.
lime trade terms, C106.
Units of weight and measure, C47.
Deflection potentiometers, S33, S79, S172, S173.
Deformation of hooks, T260.
permanent, T270.
Dehydration of clays, T21.
Demagnetizing iron in magnetic testing, S78.
Demulsibility, T86.
Denim, brown (shrunk), C256.
(unshrunk), C259.
indigo blue (shrunk), C265.
(unshrunk), C266.
Densities, photographic, microphotometer for, S385.
Density, American petroleum oils, T77.
basis, conversion of, C19.
dextrose solutions, S293.
electrical insulating materials, measurement, S471.
ethyl alcohol, S197.
gas, T89.
gas determined by effusion method, T94.
linseed oil and turpentine, T9.
measurements, C55.
modulus, T115.
molasses, T161.
petroleum oils, C59, C154.
photographic, S439.
related to composition of solutions of copper sulphate and sulphuric acid, S275.
saturated ammonia vapor, S467.
tables, standard, C19.
variation of photographic plates, S409.
Dental materials, physical properties, T157.
Deoxidation of rail steel, T241.
Deoxidized acid Bessemer steels, S346.
Dependence of magnetic hysteresis upon wave form, S106
Deposits, silver voltameter, inclusions, S271.
Depth measuring device, S507.
of focus, T217.
Derivatives of physical quantities, S331.
Deriving resistance and inductance of conductors, S374.
Description of sand-lime brick, C109.
Design, atmospheric gas burners, T193.
deflection potentiometers, S173.
heavy current resistance standards, S181.
moving-coil galvanometers, S173.
oxacetylene blowpipes, T200.
standards of mass, C3.
track scales, M9.
Detecting changes in complicated group of objects, S392.
resin in drier, T66.
Detector, alternating current and electrical wave, S22.
crystal, S94, S140, S157, C74.
electrical oscillations, S140.
waves, platinum, electrolytic, S36.
electrolytic, S22, S36, S140, C74.
electron tube, S140, C74.
electron-tube unit, C133.
crystal, C121.
for water vapor, T242.
magnetic, S140.
Detergents, *see* Reports, annual, of the director.
Deterioration, Muntz metal by corrosion, T103.
nickel spark-plug electrodes, T143.
Determination, colorimetric, of acetylene, S267.
of iron, S53.
magnetic, of iron in brass, T221.
Determining absolute viscosity, T100.
aluminum as oxide, S286.
ammonia in illuminating gas, T34.
barium carbonate and barium sulphate in rubber goods, T64.
carbon by electrolytic resistance method, T141.
in steel and iron, T33, T69.
monoxide and carbon dioxide in steels, T126.
cellulose in rubber goods, T154.
chromium, T6.
constant of radiation from black body, S262.
constants of instrument transformers, S130.
density of molasses, T161.
dew points of fuel-air mixtures, S500.
fineness of cement, T48.
focal length of converging lens, S110.
free carbon in rubber goods, T136.
gas density by effusion method, T94.
india rubber, T145.
intensity of incandescent lamps, S43, S63.
international ampere, absolute, S171.
magnetic induction in straight bars, S117.
wave form, S87.
manganese as sulphate, S186.
oil and resin in varnish, T65.
optical properties of materials, C28.
output characteristics of electron tube generators, S355.
oxygen in steels, S346, S350.
permeability of balloon fabrics, T113.
phosphorus in steels containing vanadium, T24.
ratio of electromagnetic to electrostatic unit, S65, S66.
relative wave lengths, S142.
rubber, T35.
solidification points of naphthalene and paraffin, S340.
sulphur in illuminating gas, T20.
sulphur in rubber, T45, S174.
thermal expansion of molybdenum, S332.
value of the Faraday, S218.
vanadium in steels, S161, T8.
volatile thinner in oil varnish, T76.
water, S267.
Dew points of fuel-air mixtures, S500.

*For more specific reference see table of contents of the publication cited.

Dewey decimal classification, C138.
Dextrose, solubility in sugar mixtures, T259.
solutions, density, S293.
specific rotation, S293.
standard sample, C25.
solubility in water, S437.
Dial, automatic telephony, C112.
micrometers, T226.
Diaphrams, behavior, T101.
packing, rubber, C240.
Dicyanin, application, S318.
used in photographing stellar spectra, S318.
Dielectric, absorption, S206, C74.
constant, C74.
insulating materials, measurement, S471.
of electrical insulating materials, T216.
loss, S166, S269.
see also Absorption, dielectric.
losses, use of polygonal coils, S468.
Dielectrics, effect of imperfect, S269, C74.
solid, S234, C74.
Differentiating unbleached sulphite and sulphate fibers, T189.
Diffuse light, S303.
reflecting power of substances, S196.
reflection, S261.
factors, S391.
Dilatation, thermal, of glass at high temperatures, S393.
Dilatometer, interferential, S365.
Direct combustion in oxygen method for determining carbon in steels and irons, T69.
current switchboard voltmeters and ammeters, S163.
watt-hour meters, S207.
determination of rubber, T35.
Direction finder, radio, S428.
finding, radio, S353.
of propagation of long electromagnetic waves, S353.
Directional effect, trailing wire antenna, S341.
variations, of radio signals, S476.
Directive radio transmission, S480.
radio transmisssion measurements, S469.
Director's Annual report (*see* Reports annual of the director of Bureau of Standards).
Direct-reading candlepower scale for photometers, S144.
device for computations of characteristics of tungsten lamps, S253.
instrument for measurements on electromagnetic waves, S235.
Discussion of national electrical safety code, H4.
Disintregation of concrete by alkali, T214.
Disk coils, inductance, S455.
radiating, illumination, S263.
Dispersion constants of quartz, S237.
ratio of quartz, S34.
quartz and sucrose, S268, C44.
Dispersoids, *see* Reports, annual, of the director.
Displacement law, Wien's, S180.
unit, of commodities, C77.
Distortion of electrical insulating materials, T216.
radio wave, S480.
telephony, S101.
Distributed capacity of inductance coils, S126, S326, S427, S430.
Distribution of energy in spectrum of acetylene flame, S279.
Diurnal variations, of radio signals, S476.
Domestic standards, C149.
Double polarization method for estimating sucrose, S375.
refraction, S358.
reinforced concrete beams, T182.
Double-tier steel lockers, R35.
Draft formula, pickers, T277.
Draintile, cement, in alkali soils, T44, T95.
tests, T214.
Drawing ink, specifications for black waterproof, C196.
Drier, comments on, T274.
detection of resin in, T66.
liquid paint, specification, C105.
Drop test for lenses, H2.
tests of car wheels, T209.
*Druggists' weights and measures appliances, M12.
Drums, steel barrels and, R20.
Dry capacity measures, C61.
cells, C79.
electrical characteristics and testing, C79.
specifications, C79, C139.
testing, T171.
voltage, S364.
cleaning, reclamation of gasoline, T280.
*commodities, method of sale, M14.
distillation apparatus, C145.
Drying clays after preliminary heat treatment, T1, S151.
Duck, T264.
cotton, R27.
specification, C136 C166, C167.
Ductility of brass, T83.
Duddellarc, *see* Arc, high frequency.
Duodecagonal coils, inductance, S468.
Duolateral inductance coils, S455.
Durability, cement drain tile and concrete in alkali soils, T95.
stucco and plaster, T70.
of cement tile in alkali soils, T214.
concrete in alkali soils, T 214.
sole leather, T215.
chrome and vegetable sole leathers, T286.
Duralumin, C76, S347.
thermal expansion, S497.
ultra-violet reflecting power, S493.
Dwelling construction, requirements, BH2.
recommended minimum requirements for, BH2.
Dwight, inductance formulas, S455.
Dyes absorbed by colloids in clays, T23.
see also Reports, annual, of the director.
spectral transmittancy of, S440.
used for stains, T250.
Dynamic, method in measurements on electron tubes, S351, C74.
Dynamical similarity, S394.
Dynamometer for tire tests, T213.
tests, T240.
Dysprosium, S466.

E

Earth elements, rare, preparation of, S421.
resistance related to electrolysis of underground structures, T26.
resistivity measurements, S258.
Eaves troughs, R29.
Eccentric loading of hollow tile walls, T238.
Eccentricity of tubes, T258.
Economy in use of natural gas, C116.
Edges, effect on capacity, C74.
Edison storage battery, C92.
Effect of the rolling resistance of tires on fuel consumption, T283.
time on strains in concrete and reinforcement, T236.
Effective height of antenna, S257.
resistance of antenna, S326.
and inductance of iron and bimetallic wires, S252.
wave length of transmission of pyrometer color screens, S260.
Effects, distributed capacity between inductance coils and ground, S427.
heat on celluloid, T98.
pigments on linseed oil, T71.
wave form on losses in transformers, S88.
Efficiency, daylight, of artificial illuminants, S125.
electric lamps, S113, S253, C13.
gas-mantle lamps, T110.
luminous, S305.
of the firefly, S132.
meter for incandescent lamps, S30.
of hosiery box packing, C169.
of rectifiers, T265.
Efflorescence of cement affected by Cal, T174.
Efflux of gases through small orifices, S359.
Effusion method of determining gas density, T94.
Elastic properties, fused quartz fibers, S7.
steatite fibers, S7.
Elasticity, T270.
modulus of, of sand-lime brick, T276.
of wire rope, T229.
secant modulus of, sand-lime brick walls, T276.
Electric arc, color temperature of, S443.
high-frequency oscillations, S60.
welding of steel, T179.

*For more specific reference see table of contents of the publication cited.

Electric—Continued.
condensers, testing and properties, C36.
contact devices for elevators, T202.
currents, contact rectifiers, S94, C74.
furnace, uniform temperature in, S219.
lamps, efficiency, S30.
incandescent, specifications, C13.
meters, watthour, C56.
oscillations in the receiving antenna, S157, S326, C74.
quantity, measurement, S139.
railways, construction and maintenance, T62.
current leakage, T63, T75.
service standards and rules, C56.
test fees, C6.
testing laboratory control system, S291.
units and standards, C60.
international committee report, M16.
international, S292.
waves, detector for small alternating currents, S22.
platinum electrolytic detector, S36.
wire and cable terminology, C37.
Electrical alloys of nickel, C100.
and magnetic materials, tests, C45.
characteristics of dry cells, C79.
conduction in metals, S307.
conductivity of copper, S148.
gas analysis methods based on thermal conductivity, T249.
instruments, measuring torque of, S145.
insulating materials, T216.
measuring instruments, C20.
see Reports, annual, of the director.
oscillation detectors, S140.
oscillations, high frequency, S95.
in antennas and inductance coils, S326.
practice in mines, C23.
properties of insulating materials, measurement, S471.
properties of silver sulphide, S310.
resistance of iron, S236.
safety code, C54, H3, H4.
scope and application, C72.
safety rules, C49.
separation of clay, T51.
service standards, *see* Reports, annual, of the director.
strain gage, T247.
systems grounded to promote safety, T108.
telemeter, T247.
units, S3, C29.
fundamental, selection and definition, S102.
wave detector, S22, S36.
waves at transition point, S114.
Electrically conducting helium gas, S89, S176.
Electricity measurements, C55.
units, S65, S66.
see also Reports, annual, of the director.
Electrochemical constant, S271.
equivalent, S171, S194, S201, S218, S220, S285.
Electrochemistry, *see* Reports, annual, of the director.
Electrode, cadmium, for storage battery testing, T146.
equilibrium of standard cell, S71.
potentials, S504.
Electrodeposited silver, inclusions, S271.
Electrodeposition of iron, S266.
Electrodes, spark-plug, cements, T155.
nickel, T143.
Electrodynamometer, absolute, S27, S28.
Ayrton-Jones, S56.
compensated, S48.
tubular, S184.
Electrogalvanizing, T195.
Electrolysis from electric railway currents, T32.
in concrete, T18.
mitigation, T27, T52, T54, T55.
of platinum black, S82.
prevention by insulating coatings on underground structures, T15.
see also Reports, annual, of the director.
surveys, T28.
underground structures, T26, T127.
Electrolytic corrosion influenced by varying frequencies of current, T72.
iron in soils, T25.
strip, T288.
detector, S36.
rectifiers, T265.
resistance method for determining carbon, T141.
water vapor detector, T242.
Electromagnet moving coil galvanometers, S297.
Electromagnetic unit of electricity, S65, S66.
waves, direction of propagation, S353.
Electrometer, capillary, S90.
vibration, S239.
Electrometers, S319.
Electromotive force, cells, S434.
at low temperatures, S434.
measurements, precise, C21.
waves, analysis, S119, S203.
Weston and Clark cells, S27.
Electron tube, S140, S351, S355, S381, S423, C74.
action as modulator, S423.
amplifier, C141.
detector, C133.
emission, S317.
generators, S355.
input impedance, S351.
transmitter of completely modulated waves, S381.
Electrons in cadmium vapor, resistance and ionization potentials, S317.
in lead and calcium vapors, S368.
Electroplating, S275, T190, T195, C52.
iron and steel, C80.
Electrostatic unit of electricity, S65, S66.
Electrotyping, S275.
solutions, regulation, C52.
Elements of telephone service, C112.
iron-group, melting points, S62.
nonmetallic ionization and resonance potentials, S400.
refractory, S205.
Elevator accident statistics, T202.
interlocks, T202.
Elliptic integrals, tables, S169.
Einstein, S482.
Emanations, charred paper, sensitivity of photographic materials to, S454.
Embrittlement of malleable cast iron, T245.
Emergent stem correction for thermometers, S170, T49.
Emission, spectrum, mercury, S191, S378, S495.
spectrum, neon and helium, S191.
Emissivity, S121, S198, S224, S242, S243, S249.
acetylene flame, S191.
metals and oxides, S224, S242, S243, S249.
of paints, T254.
platinum, S243.
total, relation to resistivity, S243.
tungsten filaments, S300.
Emulsification of oil, resistance to, T86.
Emulsions, photographic, sensitometry of, S439.
Enamel, red, United States specifications for, C146.
water, resisting, C146.
Enameled cast-iron wares, T142.
metal products, *see* Reports, annual, of the director.
Enameling cast iron, wet process, T246.
Enamels, calculation of formulas, T142, T165.
composition for dry process, T142.
for sheet iron and steel, T165.
ground coat, for cast iron, T246.
single coat, for cast iron, T246.
sintered ground coat, T246.
wet process, for cast iron, T246.
End restraint of columns, T263.
Endurance, high-speed lathe tools, T228.
Energy distribution, S477.
in spectrum of acetylene flame, S279, S362.
losses in condensers, S190.
measurements of star spectra, S438.
radiant, measured in absolute value, S261.
spectral distribution by Planck's Equation, Tables and Graphs, M56.
Enforcing lime-barrel act, C64.
Engesser's theory of column strength, T263.

*For more specific reference see table of contents of the publication cited.

Engineering instruments, *see* Reports, annual, of the director.
materials, properties, C101.
see Reports, annual, of the director.
Engines, aircraft, radiators for, T211.
Engler viscosimeter, T100.
English ball clays, T227.
copper wire table and units, C31, M17.
screw thread pitches, M49.
units converted to metric units, C47.
Equal-area coil, inductance calculations, S468.
Equal ordinates, Paschen's method, S162.
Equal-perimeter coil, inductance calculations, S468.
Equality-of-brightness photometer, S299.
Equalizer apparatus for brick, T251.
Equation for calculating viscosity, T112.
Planck's radiation, S304.
Equations of tungsten filament lamps, S238.
Equilibria of dextrose in water, S437.
Equilibrium conditions in the system carbon, iron oxide, and hydrogen, S350.
electrode, of standard cell, S71.
in system: lead acetate, lead oxide, water at 25°, S232.
Equivalent, luminous, of radiation, S103.
units of weight and measure, C47, M1.
mechanical, of light, S305.
Estimating sucrose, S375.
Etching, metallographic, reagents, S435.
reagents for copper, S399.
steel, T156.
Ethyl alcohol, S197.
Euler's formula, T258.
European plastic fire clays, T79.
Eutectoid carbon steel, S404.
carbon steel, magnetic properties, S408.
Evaluating the Clerget divisor, S375.
Evaporation in testing sugars, S221.
test for mineral oils, T13.
Exhaustion by reciprocating air pump, rate of, T224.
Expanded metal, tests of slabs reinforced with, T233.
Expansion, steam-turbine, S167.
tanks, simplified practice in, R8.
thermal, aluminum, S426.
American petroleum oils, T77.
brass, S321.
copper, S410.
ethyl alcohol, S197.
insulating materials, S352.
linseed oil and turpentine, T9.
measurements, C2.
molybdenum, S332, S488.
monel metal, S426.
nickel, S426.
of steels, S433.
stainless steel, S426.
stellite, S426.
Experiments in long-distance radiotelegraphy, S159.
in radiotelegraphic transmission, S226.
Exponential shape for condenser plates, S235.
Exposure, relation to photographic density, S439.
Extract, sulphite cellulose, T215.
Extraction of rubber goods, T162.
Extrapolation of high temperature scale, S260.
Eye, contrast sensibility, S366.
protection for industrial workers, H2.
sensibility, S49, S475.
Eye-protective glasses, ultra-violet and visible transmission, T119.
Eyes of industrial workers, national safety code for protection of, H2.

F

Fabric, automobile-tire, testing, T68.
Fabric-heat-transmission apparatus, T269.
Fabric-measuring devices, M51, M55, M59.
Fabrics, balloon, permeability of, T113.
specification for indelible marking ink for, C197.
Factors, diffuse reflection, S391.
of power loss in automobile tires, T213.
photographic filter, S409.
reflection and transmission, S405.
reheat, S167.
transmission and reflection, measured by Ulbricht sphere, S415.
Fading, by laundering, T273.
effect on radio reception, S476.
theory of, S476.
Fahy permeameter, S306.
Failure of brass, T82, T83, T84.
of car wheels, T209.
Clark standard cell, S390.
Faraday, value of, S218, S271.
Fatigue, T275.
testing, T275.
Fechner's law, S49.
*Federal authority regarding standards, M7.
*regulation of weights and measures, M11, M13, M41.
Specifications Board, *see* Report, annual, director of Bureau of Standards, 1924, M60.
standard barrel law, C71.
Fees, *see* separate subjects under Test, Testing, and Tests.
Feldspar related to viscosity of porcelain bodies, T50.
Felt, rag, asphalt saturated, C161.
coal tar saturated, C156.
Fence, R9.
Ferrochromium, decarburization by hydrogen, S448.
Ferronickel alloys, C100.
Fever thermometer, *see* Clinical thermometers.
Fiber rope, T121.
Fibers, paper, T250.
resembling fused quartz, S7.
stained for photomicrography, T217.
Field, fence, R9.
of radiotelegraphic antenna, effect of imperfect dielectrics, S269.
radiated from horizontal coils, S431.
Fields, intense, magnetic testing of straight rods in, S361.
Fifteenth conference on weights and measures, M51.
Figured glass, C164.
Filaments of electron tubes, S351, S355, C74.
tungsten, straight and helical, S300.
Files and rasps, simplified practice in, R6.
Files, *see* Reports, annual, of the director.
Fillers, T262.
Films, American, characteristics of, S439.
Filter factors, optical, S439.
photographic, S409.
paper voltameter, S194, S195.
Filters, light, T217.
radiometric investigation, S168.
monochromatic light, for Hg, He, and H lamps, T148.
Finance, *see* Reports, annual, of the director.
Fineness of abrasives, pigments, fillers, diatomaceous earths in cements, T48.
of cement determined by air analyzer, T48.
of grain of clays, T79.
Finger cots, rubber, C226.
Finishing, C206.
temperatures of rails, T38.
Fire brick, melting points, T10.
porosity and volume changes, T159.
Fire-clay bodies affected by size of grog., T104.
brick, T279.
Fire clays, plastic, European, T79.
Fire-extinguishing liquid, C134.
Fire hose, cotton rubber-lined, C114.
couplings and fittings, C50, M61.
Fire resistance, concrete columns, T272.
see Reports, annual, of the director.
tests of building columns, T184.
Fire-resisting tile, T120.
Fire-resistive materials, heat-insulating properties, T130.
Firefly, luminous efficiency, S132.
Fire tests, concrete columns, T272.
Firing rings, veritas, T40.
Fittings for eaves troughs, conductor pipe, and elbows, R29.
Five methods for measuring hardness, T11.
Fixed points, thermometric, C66.
Flame, acetylene, spectrum, S279, S362.
standards in photometry, S222.
Flashings, metal, C180.
plastic, C181.
Flash-light batteries, C79.

*For more specific reference see table of contents of the publication cited.

Flashover voltage of electrical insulating materials, T216.
radio-frequency, measurement, S471.
Flat interior lithopone paint, specification, C111.
Flat slab, strain gauge test, T236.
Flat spiral coils, inductance, S455.
Flaws in rifle-barrel steel, S343.
Flax packing, C239.
Flexible gas tubing, tests, T133.
Flicker photometer, S299.
Flint-lime glass tumblers, specifications, C119.
Floating crane, strain-gage test, T151.
Floor slab, test of tile and concrete, T220.
tests of hollow tile and concrete, C261.
Flow calorimeter, S503.
meters for air, T183.
plastic, laws, S278.
Fluids, cutting, T204.
Fluorite, infra-red spectral transmission of colored, S191.
refractive indices, S401.
spectroradiometers, S401.
Flux, magnetic, S87.
of light, measurement, S447.
Focal length of converging lens, S110.
Focus, depth of, T217.
Fog signaling, use of radio, S428.
signals, radio, S480.
*Food and Drugs Act, net-weight amendment, M12, M41, M55, M59.
Food dyes, S440.
Force between two coaxial circular currents, S255.
coercive, varying with magnetizing force, S384.
electromotive, at low temperatures, S434.
magnetizing, related to residual induction and coercive force, S384.
Forces on airship, due to wind, T270.
*Foreign departments, organization, weights and measures, M5.
specifications for railway materials, T61.
Forged tools, simplified practice in, R17.
*Forms, weights and measures, M1, M10, M13.
Formula for change in order of interference, S199.
temperature, of Weston cell, S104.
Formulas, mutual and self-inductance, S93, S169, S320.
mutual inductance of coaxial solenoids, S58, S169.
self-inductance, S31.
spruce struts for use in airplanes, T152.
transformers, S211.
transmission, radio, S159, S226, S354.
Winkler-Bach-Andrews-Pearson, T260.
Weinstein and Stefan, revised, S41.
Foundry, experimental, *see* Reports, annual, of the director.
practice, aluminum alloys, T139.
nonferrous, T59.
Fountain syringe, cloth-inserted, C250.
rubber, C251.
Four-terminal conductor, S181.
resistance standards, S246, S281.
Four-terminal resistors, S481.
Fourier, analysis of alternating current waves by method of, S203.
Fractionation of light-oil, T140.
Free carbon in rubber goods, T136.
Freezing point of mercury, S294.
tests of marble, T123.
Frequency, current, influence upon electrolytic corrosion, T72.
effect on signal audibility, S96, C74.
high spark, S96.
influence on resistance and inductance of coils, S76.
on solenoidal coils, S76, S169.
on self-inductance, S37.
radio, measurement, C74.
radio telegraphy, high spark, S96.
standardization by means of parallel wires, S491.
Friction of ball and roller bearings, T201.
tape, rubber, C229.
Frosted lamps, S61, S72.
Fuconic amide, preparation and properties of, S459.
Fucose, preparation of, S459.
Fuel, T283.
air mixtures, dew points of, S500.
consumption, affected by tires, T283.
effect of tires, T283.
Function of a periodic variable, S90.
Furnace, electric, S219.
modified Rosenhain, S348.
temperatures affecting porosity and volume of fire brick, T159.
Furniture, sizes, R2.
Fuses, H3.
cartridge-inclosed, T74.
Fusible tin boiler plugs, T53.

G

Gadolinium, S466.
Galactose, preparation, S416.
Galena, ultra-violet reflecting power, S493.
Galvanizing iron and steel, C80.
Galvanometer lag, S185.
mirrors, S229.
Thomson, S282.
Galvanometers, S85, S319.
critically damped, S273.
iron-clad, S188, S229, S244.
moving-coil, S173, S297.
vacuum, S204, S229, S282.
vibration, S134, S370.
Gas analysis, S267, S316, T34, T41, T89, T94.
by interferometer, T131.
by thermal conductivity method, T249.
to determine sulphur, T20.
and metal spectra intensities, S19.
burner design, T193.
burners, carbon monoxide, T212.
method of testing, T222.
efficiency of utilization, T222.
calorimeter tables, C65.
calorimeters, directions for operating, C48.
calorimetry, T36.
chemistry, *see* Reports, annual, of the director.
definition of ideal, S136.
density, T89.
determined by effusion method, T94.
detector, S334.
engineering, *see* Reports, annual, of the director.
filled lamp, photometry, S264.
heating value, standards of; natural, conservation of, M58.
helium, S89, S176, C81.
illuminating, determination of ammonia, T34.
specifications, T14.
sulphur in, T20.
interferometer calibration, S316.
lamp maintenance, T99.
lamps, T99.
leakage, small arms, S508.
measurements, C55.
measuring by cubic-foot standards, T114.
instruments, *see* Reports, annual, of the director.
*meters, testing, M11.
natural, economical use in home, C116.
pressure and intensities of some spectrum lines, S146.
service standards, C32.
test for hydrogen sulphide in, T41.
testing, standard methods, C48.
thermometer, S57.
tubing, flexible, T133.
Gases, calorimeter for, S503.
efflux through small orifices, S359.
in iron and steel, T118.
in metals, nitrogen, S457.
in steels, S346, T118, T126.
mixed, S4.
permeability of rubber to, S387.
specific gravity, determined by a balance, T89.
specific heat of, S503.
Gas-filled lamp, color of light from, S443.
Gaskets, asbestos metallic cloth, C242.
packings and, rubber, C235.
Gas-mantle lamps, efficiency, T110.
lighting conditions in 10 cities, T99.
Gasoline, C198.
air mixtures, dew points of, S500.
consumption affected by tires, C198.
deliveries, M51.
evaporation, M51.
flow meters (aircraft), T237.
gauges (aircraft), T237.
measuring pumps, testing and inspection, T81.
reclamation of, T280.
viscosity, T125.

*For more specific reference see table of contents of the publication cited.

Gauge blocks, testing and standardizing of, S436.
for sheet and plate iron and steel, C18.
of steel wire for fencing, R9.
tolerances for screw threads, M42.
Gauges, C2.
screw, M61.
wire, table of sizes, C67.
see also Reports, annual, of the director.
Gear calculations, pickers, T277.
General specifications for rubber goods, C232.
Generation of very high-frequency currents, S469.
Generator for ultra radio frequency currents, S469.
set, 5,000 volt, S25.
Generators, electron tube, S355.
Geodetic tapes, C2.
Geometric capacity, S137.
mean distances, S47, S169.
inductance calculations, S468, S455.
Geometrical theory of radiating surfaces, S51.
tables, S169.
Girder, T260.
Glass, absorption, C164.
actinic, C164.
annealing and characteristics, S358.
chipped, C164.
colored, C164.
corrugated, C164.
figured, C164.
glazing, C164.
optical, striae in, S333, S373.
ornamental, C164.
plate, C164.
pot bodies, T104.
clays, T79.
pots from American bond clays, T144.
thermal expansivities of, S485.
prism, C164.
processed, C164.
testing, H2.
thermal dilation at high temperatures, S393.
tumblers, flint-lime, specifications, C119.
volumetric aparatus, S92, C9.
window, C164.
wire, C164.
Glasses, eye-protective, T93, T119.
colored, ultra-violet and visible transmission, T148.
Glassware, chemical, tests of, T107.
Glazes, high fire porcelain, for spark plugs, T196.
leadless boro-silicate, T31.
Gloss interior lithopone paint, C147.
Gloves, rubber, surgeons', C217.
Glower, Nernst, S91.
Glycerine, infra-red spectral transmission, S418.
Goggles, H2.
Gold, arc spectrum, S411.
effect on determination of iridium, S483.
leaf radiometers, S322.
Goods, rubber, general specifications for, C232.
Government chinaware, C202.
radio publications, C122.
specifications for Portland cement, C33.
specifications, wood screws, C140.
Goutal method for determining carbon monoxide and carbon dioxide in steels, T126.
Grab method (1 by 1 by 3 inch), T264.
Grain hopper scales, manufacture, installation and performance requirements, C199.
*weighing, M41.
size of annealed carbon steels, S397.
Graphic comparison of screw thread pitchers, M49.
Graphite crucibles, bond clays for, T79.
from American bond clays, T144.
reflecting power, S152.
ultra-violet reflecting power, S493.
Graphitization of white cast iron, T129.
Grading of public utilities and service, M58.
white papers for color, T244.
Graduates, glass, C9, C61.
suitable for weights and measures officials, M12.
Grating, stigmatic concave mounting, S441.
Gravel, C158.
Gravitation, S482.
Gray absolute electrodynamometer, S27, S28.
sensation, S417.
Green paint, specifications, C97.
Grey duck, C167.
for bleaching or dyeing, C166.
Grid circuit impedance, electron tubes, S351.
modulation, radiotelephony, S423.
Grog in fire-clay bodies, T104.
Ground, capacity of inductance coils to, S175, S427.
capacity of inductance coils to, S430.
connections for electrical systems, T108.
effect on antenna resistance, S189, S257.
Grounding, H3, H4.
effect on capacity of inductance coils, S427.
effect on capacity of inductance coils, S430.
electrical equipment and lines, C49.
of electrical circuits, M58.
Ground-speed indicators, T237.
Grounds, lightning, T56.
Group of objects, detecting changes in, S392.
Gum arabic, qualitative tests and quantitative determination, T67.
Guys, H3.
Gypsum, C151, C205, C206.
fire resistance of, T130.
plaster board, C210.
properties, definitions, specifications, and uses, C108.
wall board, C211.

H

Haemacytometers, S507.
Halide salts, S456.
Hampson liquifier, S123.
Handbook of Specifications, *see* Report, annual, Director of Bureau of Standards.
Hardened carbon steels, changes upon heating, S396.
structure of, S452.
Hardening Portland cement with Cal, T174.
secondary, of high-speed steel, S395.
Brinell and scleroscope, T11.
related to grain size of steels, S397.
low-carbon, open-hearth steels, T203.
methods of measuring, T11.
red, of high-speed steel, S395.
Hardness, M62.
electrical insulating materials, measurement, S471.
Hardware, builders', R18.
Harmonic analysis of waves, S203.
Harmonics, electron tube generators, S355.
effect of phase upon acoustic quality, S127.
Harness leather, physical properties, T160.
Hartmann test for lenses, S311, S494.
Head protection for industrial workers, H2.
Head resistance of radiators, T211.
Heads and eyes of industrial workers, national safety code for protection of, H2.
Heaped bushel, C10.
Heat calorimetry, S503.
dissipated by automobile tires, T213.
etching to reveal microstructure of metals, S356.
effect upon celluloid, T98.
insulating properties of fire-resistive materials, T130.
tile, T120.
value, data, T269.
discussion, T269.
tests for textiles, T269.
insulation (textiles), T266.
latent, of fusion of ice, S209.
of pressure variation of liquid ammonia, S314.
of vaporization of ammonia, S315.
measurements, C55, S501, S503.
see also reports, annual, of the director.
of combustion, S230.
of fusion of ice, S200, S248.
resisting alloys of nickel, C100.
specific, of calcium chloride solutions, S135.
of ice, S248.
of liquid ammonia, S313.
treatment, carbon steel, T206.
duralumin, S347.
effect of, on magnetic properties of iron carbon alloys S463.
effect upon copper and its alloys, S410.
upon drying clays, S151.
upon insulating materials, S352.
high-speed steel, S395. T228.
iron-carbon alloys, S463.
light aluminum casting alloys, T139.
mercurial thermometers, S32.
molybdenum, S332.
preliminary, of clays, T1.

*For more specific reference see table of contents of the publication cited.

Heating hardened carbon steels, S396.
high-boiling oils in air, S160.
value of gas, M58.
Heat-transmission apparatus, textile fabrics, specifications, T269.
operation, T269.
Heat treatment, brass tubing, T285.
of malleable cast iron, T245.
Heaviside layer, influence on radio transmission S476.
Heavy-capacity scales, testing, M51.
Hectagraph ribbons, specification for, C187.
Hefner lamp, S227.
Height, effective, of antenna, S354.
Helical tungsten filaments, emissivity, S300.
Helium, analysis by thermal conductivity method, T249.
bibliography, C81.
emission spectrum, S191.
gas, S89, S176.
lines, intensity, S146.
Spectrum, S302.
Helmet-shaped rubber ice bag, C228.
Hertz formula for contact area, ball and roller bearings, T201
Heterochromatic photometry, S238.
"average eye" for, S299.
Heterodyne reception, C74.
Heterogeneous brasses, mechanical properties, S321.
Heusler magnetic alloys, S38.
Hexagonal coils, inductance, S468.
Hide, different parts, relative wear, T147.
wear resistance at different depths, T166.
High-boiling mineral oils, S160.
fire porcelain glazes, T196.
High frequency ammeters, S206.
circuits, S158, C74.
energy losses, S190, C74.
current, measurement, S140, S158, S206, C74.
sources, C74.
electrical oscillations, S95.
oscillations from the electric arc, S60.
resistance, S169.
inductance coils, S430.
measurement, S471.
searchlight arcs, T168.
pressure steam, effect on hardening of Portland cement mortar and concrete, T5.
test of Portland cement, T47.
rod packing, asbestos, C238
spark frequency in radio telegraphy S96.
speed steel, heat treatment, S395.
steel, lathe tests, T228.
temperature boiler plate, T219.
carbon steels, T219.
measurements, C7.
mercurial thermometers, S32.
scale, S143.
extrapolation, S260.
tensile tests of boiler plate, T219.
thermometry, S124.
treatment of high-speed steel, S395.
tension magneto, theory of induced voltage, S424.
History of standard weights and measures, S17, M64.
Hollow building tile, T120.
tile and concrete floor slab, test of, T220, C261.
slab, loading test, T236.
walls, strength of, T238.
Home, how to own your own, BH4.
Homemade radio receiving sets, C121.
Honey, solubility of sugars in, T259.
Honeycomb inductance coils, S455.
winding, S449.
Hooks, T260.
Hopper scales, hand operated, C199.
Horizontal coils, field radiation of, S431.
intensity of lamps, S43, S63.
Horsepower, relation to kilowatt, C34.
Hose couplings, M42.
and fittings for fire service, C50.
fire, cotton rubber-lined, C114.
oil suction and discharge, C209.
threads, C50, M42.
Hosiery, T253, C149, C169.
box designing, T253.
measurement, T253.
boxes, T253, C169.
measurement, C149.
packing, T253.
Hosiery—Continued.
shipping cases, C169.
sizes, C149.
standards, C169.
Hospital beds, R24.
chinaware, C202.
Hotel chinaware, C202.
simplified practice in, R5.
Hot rolling, T267.
water bottle, cloth inserted, C249.
rubber, C248.
storage tanks, R25.
wire ammeters, S206, C74.
anemometer for measuring air flow, T287.
Household materials, C70.
measurements, C55, M45.
safety, C75.
weights and measures, M39.
How to build electron-tube detector, C133.
How to own your own home, BH4.
Humidity, control tank, S471.
influence on resistances, S73.
measurements, C55.
Hydrated lime, C153.
for cooking paper rags, C96.
for glass manufacture, specification, C118.
for structural purposes, C204.
for use in the purification of water, C231.
recommended specification for, for use in the manufacture of calcium arsenate, C203.
recommended specification for, for use in the manufacture of sugar, C207.
U. S. Government master specification for, for structural purposes, C204.
Hydration of Portland cement, T43.
Hydrogen, analysis by thermal conductivity method, T249.
atomic weight, S77.
decarburization of ferrochromium by, S448.
ion concentration, S178, S364.
indicators, S286.
lines, intensity, S146.
sulphide in gas, T41.
Hydrolysis of sodium oxalate, S178.
Hydrometer scales, standard Baumé, C59.
Hydrometers, master scales, C19.
testing, C16.
Hydrostatic tests of steel tanks, T243.
Hypergeometrical series, mutual inductances of coaxial circles, S138, S169.
Hypersensitizing without the use of ammonia, S422.
Hysteresis, in measuring instruments, S328.
galvanometer, S185.
thermometric, S185.
values from high magnetizing forces, S383.

I

Ice bags, rubber, C227.
latent heat of fusion, S209.
point, thermodynamic temperature, S57.
*sale of, M41.
specific heat and heat of fusion, S248.
Icebergs, ocean temperatures near, S210.
Ideal gas, definition, S136.
Ignition apparatus, S424, T143, T155.
Illinois coal coked in Koppers type oven, T137.
Illuminants, color grading of, S443.
Illuminating engineering, *see* Reports, annual, of the Director.
gas, determination of ammonia, T34.
specifications, T14.
sulphur in, T20.
Illumination from radiating disk, S263.
Image brightness with optical instruments, C27.
Impact, T289.
excitation, radio-frequency current, S95.
strength, electrical insulating materials, measurement, S471.
Impedance, input, of three-electrode vacuum tube, S351.
Improved folding of men's hosiery, T253.
packing of men's hosiery, T253.
Incandescent lamps, efficiency, measurement, S30.
mean horizontal intensity of, S43, S63.
specifications, C13.
temperature and radiation, S40.
testing, life, S265.

*For more specific reference see table of contents of the publication cited.

Inclinometers, T237.
Inclusions in silver voltameter deposits, S271.
iron in brass, T221.
Indelible marking ink for fabrics, specification for, C197.
Independent variable, observations at equal intervals, S388.
Index, radio subjects, C138.
refractive, of air, S327.
India rubber, S174.
determined by nitrosite method, T145.
Indicator, resonance, improved type for wave meter, S502.
Indices, refractive, of rock salt, S418.
Indigo blue denim (shrunk), C265.
(unshrunk), C266.
Induced voltage in high-tension magneto, S424.
Inductance, absolute measurement, S9.
alternating-current, of conductors, S374.
of solenoids, S472.
effect of frequency, S430.
effective, iron wires, S430.
multilayer coils, S455.
coils, S468.
distributed capacity, S430.
high-frequency resistance, S430.
natural wave length, S430.
of polygonal form, S468.
polygonal coils, S468.
and capacity, distributed, in secondary coupled circuit, S126.
see also Reports, annual, of the director.
Anderson's method, measurement, S14.
calculation of mutual and self, S93, S169, S320.
circle and a coaxial single-layer coil, S56, S169.
circles, S75, S169, C74.
coaxial solenoids, mutual, S58, S59.
coils, S36, S41, S42, S47, S56, S58, S59, S74, S138.
capacity, S175.
distributed capacity, S427.
electrical oscillations, S326.
natural frequency, S326.
wave length, S427.
oscillations, S326.
distributed in coupled circuits, S126.
effect of frequency, S169, S374.
effective, iron wires, S252.
formulas, S41, S42, S169, S320.
four-terminal resistance standards, S281.
high-frequency, S169, S252, S374, C74.
iron and bimetallic wires, S252.
linear conductors, S80.
low-resistance standards, S246.
measurement by Anderson's method, S14.
mutual, S492, S498.
mutual and self, calculation, S169.
formulas, S320.
mutual circle and a coaxial coil, S56.
coaxial circles, S55, S41.
solenoids, S58, S59.
parallel coaxial circles, S138.
two circular coaxial coils, S42.
residual, resistance standards, S175, S177, S246, S281.
resistance coils, S175.
self and mutual, of conductors, S80.
coil, S83, S169, C74.
solenoidal coils, S76, S84.
standards, S29.
serpentine, S15.
toroidal coil, S74.
use of serpentine in standards, S15.
variable, S290.
see also Reactance, distributed.
Induction coils, S424.
magnetic, in straight bars, S117.
residual, varying with magnetizing force, S384.
Induction measurement in short bars, S458.
Inductive coupling, S487.
feed back, study of, S487.
interference, M58.
Inductively coupled circuits, S158.
Inductometer, S290.
Inductor, self and mutual, S290.
variable, for radio set, C120.
Industrial gas calorimetry, T36.
*plants, weights and measures apparatus, M14.
workers, head and eye protection, H2.
Influence, frequency, solenoidal coils, S76.
of frequency upon self-inductance of coils, S430.
upon self-inductance of coils, S37, S169, S374.
wave form on rate of wattmeters, S21.
Information manual for weights and measures officials, H1, M1.
see also Report, annual, of the director.
Information, radio, C122.
Infra-red absorption and reflection spectra, S45.
rays, protecting eyes from, T93.
transmission and refraction data, S401.
spectra, S466.
spectral transmission, bakelite, S418.
celluloid, S418.
chitin, S168.
copper sulphate, S168.
cupric chloride, S168, S191.
fluorite, S191.
gellatin, S168.
glycerin, S418.
linseed oil, S168, S418.
of colored fluorite, S191.
rock salt, wave length corrections, S418.
selenite, S418.
sybite, S168.
Ingots, sink-head and ordinary rail, T178.
Initial strain, T101.
Ink, analysis, T39, C53, C95.
canceling, C95.
composition, C95.
copying, C95, C182.
duplicating, C95.
manufacture, C95.
marking, C95.
powders, C95.
printing, T39, C53.
record, specification for, C182.
red, specification for, C184.
specification for, C182.
specification for black waterproof drawing, C196.
specification for indelible, for fabrics, C197.
stamping, C95.
stamp-pad, specification for, C185.
sympathetic, C95.
tablets, C95.
testing, T39, C53, C95, M15.
writing, specification for, C183.
Inlaid linoleum, C190.
Inner tubes, specifications, C115.
Input impedance of three-electrode vacuum tube, S351.
Inspecting large capacity scales, T199.
leather, T153.
meter provers, T114.
Inspection manual for weights and measures officials, H1, M1.
Inspector, radio, C122.
Inspectors, weights and measures, M1, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M41, M43, M48.
Installation of plastic flashings, C181.
of metal flashings, C180.
of railroad track scales, C83.
Instrument for measuring reflection and transmission factors, S405.
transformers, S130.
testing, S233.
Instruments, electrical, S163.
electrical, measuring torque of, S145.
measuring, electrical, C20.
variance related to accuracy and sensitivity, S328.
methods, high-frequency measurement, C74.
optical, testing and properties, C27.
radio, C74.
showing combustible gas in air, S334.
used in radiometry, S85, S188, S319.
Insulated feeder system on electric railway line, T54.
negative feeders on electric railway lines, T32.
tape, rubber, C230.
Insulating materials, electrical, T216.
study of the seasonal variation of radio-frequency phase difference, T284.
thermal expansion, S352.
volume and surface conductivity, S234.
pipes to prevent electrolysis, T15.
properties, measurement, S471.

*For more specific reference see table of contents of the publication cited.

Insulating materials, electrical—Continued.
properties of solid dielectrics, S234, S352, C74.
value of marble, T123.
Insulators, effect on antenna resistance, S269.
Integrating induction wattmeters, S21.
Integration method of deriving resistance and inductance of conductors, S374.
Intensities, hydrogen, argon, and helium lines, S146.
metal and gas spectra, S19.
spherical and hemispherical, S12.
Intensity, incandescent lamps, S43, S63.
light source, S26.
sources, S44.
luminous, units, S50.
measurements, sound, S473.
Intercomparing radiation data, S360.
Intercrystalline brittleness of copper, T158.
lead, S377.
Interfacial tension of oils, T223.
Interference, S477.
apparatus, S507.
bands, oscillatory, S150.
change in order of, S199.
measurements in spectra of argon, krypton, and xenon, S414.
of wave lengths, S142, S179, S251, S274, S302, S329, S414.
methods for standardizing gauge blocks, S436.
testing gauge blocks, S436.
phenomena photography, S441.
Interferential dilatometer, S365.
Interferometer, gas, calibration, S316.
used in gas analysis, T131.
Interferometry, *see* Reports, annual, of the director.
Intergrating sphere, photometric, S447.
Interior varnish, specification, C117.
Intermittent testing, T171.
Internal stresses in brass, T82.
resulting from welding, T84.
in brass tubing, T285.
International adoption of electrical units, S102.
ampere, S171.
committee on electric units and standards, report to, M16.
electrical units, S3.
hydrogen scale of temperature, S69.
metric chart, M3.
system of weights and measures, M2.
system of electric and magnetic units, S292.
unit of light, C15.
volt, value, C29.
Invar, properties, C58.
Inverse fading, of radio signals, S476.
Inverse-rate method for thermal analysis, S336.
Inverse-rate method of thermal analysis, recording chronograph for, T230.
Invert sugar, "solubility" of, T259.
*Investigation of weights and measures by Bureau of Standards, M9.
Investigations, radiometric, of spectra, S45.
Iodine number of linseed and petroleum oils, T37.
voltameters, S218.
Iodine pentoxide apparatus for carbon monoxide, T222.
spectrophoto-electrical properties, S462.
Ionization, atomospheric radio transmission, S159, S226.
potentials, electrons in cadmium vapor, S317.
lead and calcium vapors, S368.
six nonmetallic elements, S400.
Iridium arc spectrum, S499.
reflection, S45.
spectrographic examination of, S483.
Iron, alloys with carbon and manganese, S453.
analysis, T33, T118, C14.
arc, spectrum, S324, S478, S479.
bimetallic wires, inductance, S252.
car wheels, thermal stresses in, T209.
carbon alloys, S266.
effect of manganese on microstructure of, S464.
magnetic properties of, S463.
thermal analysis, S484.
cast, graphitized upon annealing, T129.
locomotive-cylinder parts, T172.
thermal expansion of, S433.
wet process enameling of, T246.
clad galvanometer, S188, S229, S244.
colorimetric determination of, S53.
core transformer, S449.
Iron, alloys with carbon and manganese—Contd.
critical ranges, S213, S296.
demagnetization in magnetic testing, S78.
determining carbon in, T33.
determination of nitrogen in, S457.
effect on determination of iridium, S483.
electrodeposition of, S266.
electrolytic, thermal expansion of, S433.
electrolytically corroded in soils, T25.
etched by ammonium persulphate, S402.
group elements, melting points, S62.
in brass, T221.
microstructure, T221.
in cast red brass, T221.
inclusions in brass, T221.
loss equations, S164.
losses in transformers, S88.
microstructure at high temperatures, S356.
ores, analysis, C26.
oxide and iron-hydroxide paints, specification, C93.
emissivity, S249.
oxygen by Ledebur method, T118.
pure, electrical resistance and critical ranges, S236.
red shortness of, T261.
rustproofing, C80.
separation from iridium, S483.
sheet and plate, gauge, C18.
enamels for, T165.
spectrum, S251, S274.
thermoelectric properties, S120.
wires, resistance, S252.
wrought, microstructure, T97

J

Jacks, telephone, C112.
Jewelry, fraudulent marking, M55.
*Jewelers' weights and measures appliances, M12.

K

Kärman's theory of column strength, T263.
Keene's, C151.
Kilowatt, relation to horsepower, C34.
Kitchen card, M39.
Knit goods standards, C149.
tubing, laundering, T273.
Koepsel permeameter, S228.
Kolster decremeter, S235, C74.
König's data, S154.
Koppers type oven for coking Illinois coal, T137.
Krypton spectrum, S414.
wave lengths in, S345.

L

Laboratory ware, porcelain, T105.
wearing test on different depths in a hide, T166.
Lace leather, C213.
Lacquered silver, reflecting power, S342.
Ladies' hosiery boxes, T253.
Lag, *see* Hysteresis.
Laminated phenolic insulating materials, T216.
Lampblack, reflecting power, S196.
Lamps, arc, cadmium vapor, S371.
carbon, photometry of, S115.
efficiency, S113.
gas, T99.
gas-filled, photometry, S264.
gas-mantle, efficiency, T110.
incandescent, efficiency, measurement, S30.
life testing, S265.
mean horizontal intensity of, S43, S63.
specifications, C13.
pentane, S216.
plain and frosted, S72.
quartz mercury vapor, S330.
quartz mercury vapor, component radiations, S378.
standard, S222.
temperature and radiation, S40.
tungsten, compared with glass screens, S277.
comparison, S115.
filament, equations, S238.
vacuum tungsten, S253.
Lantern films, protection from heat of lamp, S378.
Lanthanum, arc spectrum, S421.

*For more specific reference see table of contents of the publication cited.

Large capacity scales, tests, T199.
Latent heat, calorimeter for, S301.
of fusion of ice, S209.
of pressure variation of liquid ammonia, S314.
of vaporization of ammonia, S315.
Lath, C151.
metal, simplified practice in, R3.
Lathe tests, high-speed steels, T228.
Lattice bars, behavior, T101.
Lattice-wound inductance coils, S455.
Laundry soap, T273.
tests of soap, T273.
Lavage tubes, C220.
Lavatory and sink traps, brass, R21.
Law, Fechner's, S49.
Federal standard barrel, C71.
*Standard barrel, interpretation, M13.
*Model, on weights and measures, M4, M9, M11, M13.
*net-weight amendment to Food and Drugs Act, M12, M41.
Planck's, S259.
Wien's displacement, S180.
Laws defining electrical units, S3.
Federal, weights and measures, M1.
plastic flow, S278.
radiation from a black body, S406.
radio, C122.
standard State zoning enabling, M54.
weights and measures of the United States, M20.
Lead, S456.
acetate test for hydrogen sulphide in gas, T41.
antimony sulphide, spectrophoto-electrical sensitivity of, S462.
arc spectrum, S411.
corrosion of, S377.
intercrystalline brittleness, S377.
photo-electrical properties of halide salts of, S456.
red, comments on, T274.
specifications, C90.
standard for melting point, C25.
standard samples, C66.
vapors, electrons in, S368.
white, specification for basic carbonate, C84.
comments on, T274.
for basic sulphate, C85.
Leaded zinc oxide, specifications, C88.
Leadless borosilicate glazes, T31.
Leakage, current, from electric railways, T63, T75.
reactance, transformers, S455, S468.
resistance of street-railway roadbeds, T127.
Least squares, theory, S304.
Leather, C148.
belting, vegetable tanned, C148.
durability, T215.
lace, C213.
harness, physical properties, T160.
measurement of area, T153.
measuring machines, M51.
sole, durability, T215, C198.
relative wear, T147.
specification, C198.
wearing quality, T138.
tests, C45.
see also Reports, annual, of the director.
upholstery, C212.
wear tests for, T215.
Leathers, sole, chrome and vegetable, T286.
Ledebur method, S346, S350.
limited practical use, T118.
Legal specifications for illuminating gas, T14.
weights per bushel of various commodities, C10.
*Legislation, model law on bread, M48.
proposed, standard barrel bill, M9, M12.
Length, focal, of converging lens, S110.
measurements, C2.
standards, S17.
verification, S1.
see also Reports, annual, of the director.
Lens, converging, S110.
material, standard, S401.
testing, H2.
axial aberrations, S311.
Lenses, nonaxial aberrations, S494.
spherical aberration of thin, S461.
Leyden jars, energy losses, S190.
Library, *see* Reports, annual, of the director.
Licenses, radio, C122.
Life, frosted lamps, S61, S72.
lamps, C13.
machine-gun barrels, T191.
testing of incandescent lamps, S265.
Light alloys of aluminum, properties, C76.
aluminum casting alloys, T139.
filters, S191, T217.
radiometric investigation, S168.
forces in polariscopic measurements, S34.
measurements, C55.
mechanical equivalent, S305.
mercury arc, S128.
oil fractionation, T140.
reflection, S391, S405.
sources, monochromatic, S44.
tubes, S51.
unit, international, C15.
velocity, S65.
waves, length, S251.
in standardizing gauges, S436.
weight duck, C166.
see Reports, annual, of the director.
Lighthouses, radio beacons, S428.
Lightning protection, T56.
Lime, C150, C151, C152, C153, C201.
bags of paper, T187.
barrel law, M1.
enforcement, C64.
definitions and specifications, C106.
for glass manufacture, specification, C118.
hydrated, U. S. Government master specification for, for structural purposes, C204.
for structural purposes, C204.
manufacture, T16.
powder, recommended specification for, for use in the manufacture of sugar, C207.
properties and uses, C30.
recommended specification for, for use in the purification of water, C231.
specification, for absorption of carbon dioxide, C189.
for cooking paper rags, C96.
tests, C45.
see also Reports, annual, of the director.
Limestone for glass manufacture, specification, C118.
for use in manufacture of sulphite pulp, C144.
recommended specification for, for use in the manufacture of sugar, C207.
Limitation of varieties of paints and varnishes, L1.
Line construction, H3.
rules for electrical workers, C49.
Linear conductors, inductance, S80.
curves, S388.
measures, C2, C61.
Lines, spectrum, S34.
Linoleum, battleship, C191.
plain, inlaid and printed, C190.
Linseed oil, affected by pigments, T71.
comments on, T274.
density and thermal expansion, T9.
infra-red spectral transmission, S168, S418.
specification, C82.
Linseed oils, iodine number, T37.
Liquefaction of air, S123.
Liquefier, Hampson, S123.
Liquid air plant, *see* Reports, annual, of the director.
production on a laboratory scale, S419.
ammonia, latent heat of pressure variation, S314.
of vaporization, S313.
specific heat, S313.
volume, S420.
capacity measures, C61.
laundry soap, T273.
specification, C193.
measuring devices, C61, M51.
pumps, T81, M14, M41, M43, M48.
paint drier, specification, C105.
Literature, radio, C122.
classification, C138.
Lithopone paint, specification, C111, C147.
Load carrying ability of refractories at furnace temperatures, T7.
critical, on ball and roller bearings, T201.
plate circuit, S351.
test of crane, T151.
Load-deflection method, T275.

*For more specific reference see table of contents of the publication cited.

Loaded paper shot shells, R31.
Loading coil, C137.
specification, H4.
test of reinforced hollow tile slab, T236.
Lockers, steel, R35.
Locomotive-cylinder parts, T172.
Logarithmic decrement, S235, C74.
electromagnetic waves, S235.
Logging Safety Code, H5.
Long distance radiotelegraphy, S159.
telephony, C112.
Loop antenna, S428.
Lorenz apparatus, S56.
Losses, antenna, S269.
high-frequency circuits, energy, S190, C74.
energy in condensers, S190.
in transformers, S88.
power, in automobile tires, T213.
Low carbon, open-hearth steels, T203.
resistance standards, inductances of, S246.
resistances, measurement of, S225.
voltage arcs for metals of second group of periodic table, S403.
in caesium vapor, S386.
Low-pressure spiral gland packing, C237.
Low-resistance measurements, S481.
Lubricants for wire rope, T121.
Lubricating oils acted upon by sunlight and air, S153.
carbonization, C99.
mineral, T13.
carbonization of, T4.
testing, C45, M15.
see also Reports, annual, of the director.
Lubrication of wire rope, T229.
Lumber, simplified practice in, R16.
Luminosity and temperature, S133.
of a black body, S270.
screen, S303.
Luminous efficiency of the firefly, S132.
of radiant energy, S475.
equivalent of radiation, S103.
intensity units of four countries, S50.
properties of helium gas, S89, S176.
radiation from black body, S305.
Lunch-counter chinaware, C202.
Lyle, inductance formulas, S455.

M

Machine-gun barrels, life, T101.
Machinery, cotton, T277.
calculations, T282.
Machining qualities of electrical insulating materials, T216.
Macrostructure of iron and steel revealed by ammonium persulphate, S402.
Magnesia, T239.
content as affecting properties of Portland cement, T102.
crucibles, S453.
Magnesite, T239.
cement, C135.
stucco, C135.
Magnesium alloys, mechanical and anticorrosive properties, T132.
critical potentials, S403.
Magnetic alloys, Heusler, S38.
analysis of rifle-barrel steel, S343.
compasses, S382.
determination of iron in brass, T221.
flux, waveform, S87.
hysteresis, dependence upon wave form, S106.
induction in straight bars, S117.
measurements, S458, *see* Annual reports of the Director.
permeability, temperature coefficient, S245.
of brass containing iron, T221.
of short bars, apparatus for determining, S458.
properties, S384.
of iron-carbon alloys, S463.
of steel, S272, S408.
and mechanical stress, S496.
rectifiers, T265.
reluctivity relationship, S404.
shielding, S188.
tests of Thomson galvanometer, S282.
standard bars, S295.
susceptibility of brass containing iron, T221.
Magnetic alloys—Continued.
test fees, C6.
testing, S78, S228, S245, S295, S306, S382, C17.
straight rods, S361.
with ring specimens, S108.
units, international, S292.
Magnetite, analyzed iron ore, C25.
Magnetizing current and regulation of potential transformers, S129.
force related to residual induction and coercive force, S384.
forces, hysteresis values, S383.
Magneto, high-tension, theory of induced voltage, S424.
telephone system, C112.
Mahogany standards of inductance, S15.
Mail-bag duck, T277.
Mails, *see* reports, annual, of the Director.
Maintaining rail joints and bonds in electric railways, T62.
Maintenance of gas lamps, T99.
Malleable cast iron, embrittlement of, T245.
heat treatment to reduce brittleness, T245.
Malleability of nickel, T281.
Manganese, analyzed ore, C25.
arc spectrum, S372.
bronze, "burned in," T84.
exposed to corrosion under tensile stress, T135.
determination as sulphate, S186.
dioxide, C79.
effect on red shortness of iron, T261.
effect upon structure of carbon steels, S464.
effects on mechanical properties of pure iron, S453.
ores, analysis, C26.
Manila rope tests, T198.
Mannose, preparation, S429.
Manual, metric, for soldiers, M21.
of inspection and information for weights and measures officials, H1, M1.
telephone switchboard, C112.
systems, C112.
Manufacturing inks, C95.
lime, T16.
railroad track scales, C83.
sand-lime brick, T85.
steel, T91.
steel plates containing zirconium, T207.
Marble standards of inductance, S15.
thermal expansion, S352.
Marbles, commercial, S352, T123.
physical and chemical tests, T123.
Marine sextants, specifications, C110.
Marine standards committee, American, organization of, RX.
Martens, inductance formulas, S468.
Martensite in carbon steels, S452.
Marking ink, specification for indelible, for fabrics, C197.
Martens' polarization photometer, S367.
Marvin pyrheliometer, S323.
Masonry wall construction, minimum requirements for, BH6.
Mass, standards, S17.
design and test, C3.
see also Reports, annual, of the director.
Match, color, vs. spectral intensity, S156.
Materials, dental, physical properties, T157.
for concretes, T58.
for the household, C70.
insulating, electrical, T216.
insulating, thermal expansion, S352.
miscellaneous, tests, C45.
optical properties, C28.
paint, testing, M15.
photographic, sensitivity to charred paper emanations, S454.
physical properties, C101.
properties of, T275.
railway, foreign specifications for, T61.
testing, C45, M62.
textile, testing and properties, C41.
used in enamels for cast-iron wares, T142.
Mathematical theory of induced voltage in magneto, S424.
Matthews and Russell-Léonard photometers, theory, S12.
Mattresses, sizes, R2.
Maximum solubility of sugar mixtures, T259.
Maxwell bridge, S10.

*For more specific reference see table of contents of the publication cited.

Mean horizontal intensity of incandescent lamps, S63, S43.
Measurement of high pressures, piezo-electric method for, S445.
of hosiery, sizes, C149.
magnetic properties of short bars, S458.
of resistance, S481.
of twist angle of cotton yarn, T278.
properties of electrical insulating materials, T216.
properties of electrical insulating materials, S471.
wave lengths, in neodymium spectra, S442.
energy distribution in star spectra, S438.
wave length, samarium spectra, S442.
Measurements, absolute, of capacity, S10.
of resistance, S111.
electric, at high frequencies, C74.
for the household, C55, M45.
length and area, C2.
of thermal dilatations, S485.
polariscopic, S34.
precision attainable where results are dependent on density, S409.
radio, C74.
temperature and selective radiation of lamps, S40.
see also Measuring.
Measures, M55, M59.
capacity, testing, M11.
dry and liquid, C4.
metric system, M2.
specifications and tolerances, C61.
specifications and tolerances, M55, M59.
Measuring air flow through engine radiators, T287.
alternating-current, S297.
area of leather, T153.
capacity, S10.
capacity and power factor of condensers, S64.
core loss, S109.
critical ranges of pure iron, S296.
current and voltage, S172.
diffuse reflection factors, S391.
earth resistivity, S258.
electric oscillations in antenna, S157.
electric quantity, S139.
emf and current, S33.
emissivity, S242.
hardness, T11.
heat of stars, S244.
high temperatures, C7.
hysteresis values from high magnetizing forces, S383.
inductance, S9, S14, C74.
low-resistance standards, S246.
resistance coils, S175.
instruments, electrical, C20.
variance related to accuracy and sensitivity, S328.
interference of wave lengths, S251, S274.
logarithmic decrement and wave length of electromagnetic waves, S235.
low resistances, S225.
oscillations in automobile battery circuits, T186.
photographic filter factors, S409.
plasticity of clays, T46.
plasticity of mortars and plasters, T169.
potentials, S364, T146.
power expended upon condensers and circuits, S18.
factor of condensers, S64.
*pumps, M14, M41, M43, M48.
radiant energy in absolute value, S261.
radiation standards in absolute value, S227.
radiations from sun and quartz mercury vapor lamp, S378.
reflection and transmission factors, S405.
refractive index of air, S327.
relative wear of sole leather, T147.
resistance and emf, C21.
of electrolytic conductors, S258.
screw threads, M61.
spherical and hemispherical intensities, S12.
standard sieves, C39.
temperature in Bessemer and open-hearth practice, T91.
in ceramic kilns, T40.
thermal dilatation of glass, S393.
time, C51.
torque of electrical instruments, S145.
Measuring—Continued.
wave lengths in arc spectra, S312, S411.
in neon spectrum, S329.
in spectra of krypton and xenon, S345.
*Meats, wrapped, enforcement of law regarding, M48.
Mechanical equivalent of light, S305.
metallurgy, *see* Reports, annual, of the director.
plant of the Bureau of Standards, *see* Reports, annual, of the director.
properties, brasses, S321.
carbon steel, T206.
rolled light alloys, T132.
steel, S272.
properties of electrical insulating materials, T216.
measurement, S471.
pure iron and alloys with carbon and manganese, S453.
tests, *see also* Reports, annual, of the director.
Medium and light rust-preventive compounds, C214.
Melting points, chemical elements, C35.
fire brick, T10.
iron-group elements, S62.
metals, S124, S143.
palladium and platinum, S55.
refractory elements, S205.
oxides, S212.
standard samples, C25.
Men's hosiery boxes, T253.
Mercurial barometers, testing of, C46.
resistance standards, S256.
thermometers, high temperature, S32.
stem correction, S170.
Mercury arc, light from, S128.
spectrum, S411.
barometers, testing of, C46.
critical potentials, S403.
freezing point, S294.
ohm, S102, S256, M16.
surface, setting of, S214.
Metal and gas spectra intensities, S19.
flashings, C180.
lath, simplified practice in, R3.
structures, *see* Reports, Annual, of the director.
Metallic coatings for rustproofing, C80.
Metallographic etching reagents, S435.
etching reagents for copper, S399.
features revealed by etching steel, T156.
testing, C42.
Metallography, aluminum and its alloys with copper and magnesium, S337.
method, C113.
of nickel; oxide eutectic, sulphides in nickel, T281.
Metallurgy, physical, C42.
see also Reports, annual, of the director.
Metals, analysis, *see* Reports, annual, of the director.
electrical conduction, S307.
Metals, emissivity, S224, S242, S243, S249.
mechanical working, T163.
melting points, S124.
microscopy, C113.
protection in storage, T176.
radiation constants, S105.
reflecting power of, S152.
second group of periodic table, S403.
standard temperature samples, C25.
strengths and related properties, C101.
structure and related properties, C113.
tests, C45.
Meteorological conditions, effect on radio transmission, S476.
Meter, efficiency, for incandescent lamps, S30.
prototype, recomparison, S1.
provers, inspection and testing, T114.
watts-per-candle, S113.
Meters, electric, C20, C56.
flow, for air, T183.
gas, testing, M11.
water, testing, M11.
watt-hour, direct-current, S207.
Method of Fourier, analysis of alternating-current waves, S203.
radiation, for determining melting points, S62.
Method for preparing raffinose, S432.
interference, for standardizing gauge blocks, S436.
for testing gauge blocks, S436.

*For more specific reference see table of contents of the publication cited.

Method—Continued.
for manufacturing enameled cast-iron wares, T142.
for measuring electrical resistance, S223.
high resistances, S234.
of determining dew points of fuel-air mixtures, S500.
of expressing weight of duck by square yard, basis, C136.
of inspecting and testing soap, T273.
of preparing concretes, T58.
of testing oils, T223.
Methods, calculating radiation constants, S284.
determining ratio of electromagnetic to electrostatic unit, S66.
testing soap, C62.
used in radiometry, S85.
see also each special subject.
of testing ducks, C136.
of testing radio receiving sets, T256.
Methyl tetronic acid lactone from fucose, properties of, S459.
amide from fucose, properties of, S459.
Metric carat, C43, M3.
copper-wire units, M17.
manual for soldiers, M21.
screw thread pitches, M49.
screw threads, M49.
system, S17, C47, M2, M3, M12, M14, M21, M41.
units converted to English units, C47.
Mica condensers as standards of capacity, S137.
Micrometers, T226.
Microscopes, micrometer, S215.
Microscopy of fibers, T250.
of metals, C113.
Microstructural changes in burning silica refractories, T116.
Microstructure, changes in annealing cast bronze, T60.
copper, S399.
iron and mild steel, S356.
low-carbon, open-hearth steels, T203.
molybdenum, S488
of brass containing iron, T221.
porcelain, T80.
silica brick, T124.
wrought brasses, T82.
wrought iron, T97.
Microphotometer for photographic densities, S385.
Micropyrometer, S198.
for measuring emissivity, S242.
Milk bottle requirements, M55, M51, M59.
bottles, C61.
and milk bottle caps, simplified practice in, R10.
Millboard, asbestos, simplified practice in, R19.
Mill, cotton, T282.
organization for No. 7's yarn, Pima cotton, T277.
Mill white, gloss paint, C147.
Milled toilet soap, specification, C194.
Milling cutters, R36.
Mineral lubricating and transformer oils, T13.
oils, carbonization, T4.
oils, high-boiling, S160.
spirits for thinning paints, C98.
spirits, comments on, T274.
surfaced roofing, asphalt for, C159.
*Mine scales, M41, M48.
Minimum live loads allowable for use in design of buildings, BH7.
requirements for masonry wall construction, BH6.
for small dwellings, BH1.
surface for definite volume, C169.
Mining electrical practice, C23.
Mitigation of electrolysis, T27, T52, T54, T55.
Mixed gas spectra, S4.
paints, comments on, T274.
Mixture ratio, effect on fuel dew point, S500.
*Model law on bread, M48.
*on weights and measures, M9, M11, M13.
Modified Rosenhain furnace, S348.
Modulated waves, electron tube transmitter of, S381.
Modulator tube, operation in radio telephone sets, S423.
Modulus of elasticity of tiles, T120.
of wire rope, T229.
of rupture, brick, T251.
of sand-lime brick, T276.
tangent, and column strength, T263.
Mohair yarns, scouring, T273.
Moisture absorption, electrical insulating materials, measurement, S471.
content (press cloth), T231.
Molasses, density determined by picnometer, T161.
recovery of by-products from, C145.
Molding, C206.
Mollier, chart of properties of ammonia, M52.
diagram, S167.
Molybdenite, artificial preparation, S462.
chemical analysis, S462.
Molybdenite, optical photoelectric properties, S338.
photoelectrical properties, S398, S462.
photopositive and photonegative properties, S398, S462.
polarization by reflection, S338.
spectral reflection, S325, S338.
transmission, S338.
thermoelectrical and actinoelectrical properties, S486.
ultra-violet reflecting power, S493.
Molybdenum, arc spectrum, S372.
photo-electrical properties of oxide and sulphides of, S322, S338, S398, S462.
reflecting power, S152.
series in the arc spectrum of, S474.
thermal expansion, S332, S488.
Moments and stresses in floor slab, T220.
Monel metal, C100.
reflecting power, S379.
thermal expansion, S426.
Monochromatic light filters for Hg, He, and H. lamps, T148.
sources, S44.
Mooring spindle, T270.
Mortar, compressive strength of, T276.
for brick work, T111.
in sand-lime brick walls, deformation of, T276.
materials used, sand-lime brick walls, T276.
tensile strength of, T276.
Mortars, plasticity, T169.
Portland cement, T3, T5.
Motor-truck wheels, physical tests, T150.
Moving-coil galvanometers, S173, S297.
Multilayer coils, inductance, S455.
polygonal, inductance, S468.
Multiple-layer inductance coil, S320.
Munsell color system, T167.
Muntz metal, deterioration by corrosion, T103.
type of brasses, S321.
Mutual inductance, S93, S169.
calculation, S93, S169, S320.
calculations, S495.
circle, S56, S169.
circle and a coaxial coil, S56.
of coaxial circles, S495.
coaxial coils, S41, S169.
solenoids, S58, S59, S169.
formulas, S41, S42.
solenoids, S58, S59.
conductors, S80.
determinations, S492, S498.
formulas, S169, S320.
linear conductors, S80, S169.
of circular circuits, S495.
of circular filaments, S495.
multilayer coils, S455.
polygons, S468.
parallel coaxial circles, S138.
two circular coaxial coils, S42, S169.
parallel coaxial circles, S138, S169.
variable, S117, S169, S290.

N

Nagaoka inductance formula, S169, S455.
Naphthalene combustion heat, S230.
solidification point, S340.
standard for calorimetry, C25.
National Bureau of Standards, C1, M18.
conferences on weights and measures. *See* Annual conferences on weights and measures.
electrical safety code, C54, H3, H4.
scope and application, C72.
safety code for head and eye protection, H2.
screw thread commission, progress report, M42, M61.
see also Reports, annual, of directors.

*For more specific reference see table of contents of the publication cited.

Natural frequency of inductance coils, S320.
gas in domestic gas appliances, C116.
scale of pure color, S118.
wave length of inductance coils, S427, S430.
Natural gas burners, carbon monoxide, T212.
conservation of, M58.
Navigation by radio direction finder, S428.
instruments (aircraft), T237.
radio aid to, S480.
use of radio in, S428.
Neat plaster, C205.
Needle valve, S419.
Negative photo-electrical properties, S398, S462.
of molybdenite, S398.
Neodymium arc spectra wave-length measurements, S442.
Neon, emission spectrum, S191.
gas spectrum, S251.
spectrum, S329.
wave lengths, S179.
Nernst glower, S91.
*Net-weight amendment to food and drugs act, M12, M41.
Neutrality, chemical, test for, S178.
Nick-bend test for wrought iron, T252.
Nickel, C100.
alloys, C100.
arc, spectrum, S324.
deterioration, T143.
effect of sulphur upon properties of, T281.
etching reagents, S435.
malleability and metallography of, T281.
oxide, S224.
spark-plug electrodes, T143.
steel standards for analysis, C25.
steels, critical ranges, S376.
properties, C58, C100.
thermal analysis, S376.
thermal expansion, S426.
Nitrates in battery acid, T149.
Nitrites in battery acid, T149.
Nitrogen in iron and steel, S457.
spectral classifications, S490.
Nitrosite method for rubber determination, T35, T145.
Nocturnal variation, of radio signals, S476.
Nomenclature, photometric, S141.
Nomographs, cotton pickers, T277.
Noncondensible gases in ammonia refrigeration machines, T180.
Noninductive resistances, S246, S281.
resistance coils, S177.
Notched bar, T289.
Null method, for photoelectric spectrophotometry, S349.
Numbered cotton duck, T264.
specification, C136, T264.

O

Objectives for photographic use, T217.
for visual use, T217.
resolving power, S122.
Observations at equal intervals of independent variable, S388.
Ocean temperatures, S210.
Ocher, comments on, T274.
specification, C91.
Octagonal coils, inductance, S468.
Office, *see* Reports, annual, of the director.
Officials, weights and measures, manual for, H1, M1.
Ohm, mercury, S102, S256, M16.
tubes, S256.
Oil content (press cloth), T231.
emulsification, resistance to, T86.
in varnish, T65.
linseed, affected by pigments, T71.
comments on, T274.
density and thermal expansion, T9.
pressing, T231.
specification, C82.
slushing, C200.
suction and discharge hose, C209.
varnish, volatile thinner, T76.
Oils, automobile cylinder, oxidation, T73.
interfacial tension of, T223.
lubricating, acted upon by sunlight and air, S153.
carbonization, C99.
testing, M15.
methods of testing, T223.
mineral, high-boiling, S160.
lubricating and transformer, test, T13.
mineral, lubricating carbonization, T4.
national standard petroleum oil tables, C154.
organic acidity of, T223.
petroleum, containing sulphur, T177.
density and thermal expansion, T77.
oxidation, S153, S160.
reclaimed, T223.
refining, T223.
standard tables, C57.
slushing, T176.
tension, interfacial, T223.
test methods, T223.
Olive drab paint, C165.
Opacity, tracing cloth and paper, C63.
see also, Absorption, and Transmission.
Open-hearth, low-carbon steels, T203.
practice, temperature measurements, T91.
steel, cold-rolling tests of, T288.
Operating modulator tube in radio telephone sets, S423.
oxyacetylene blowpipes, T200.
pads, rubber, surgical, C245.
vehicle-type batteries, C92.
Operation of simple radio receiving outfit, C120.
Operator license, radio, C122.
Operators, telephone, C112.
Optical conditions accompanying striae in optical glass, S333.
glass, *see* Reports, annual, of the Director.
striae, S333, S373.
instruments, testing and properties, C27.
see also Reports, annual, of the director.
materials, tests, C45.
metallurgy, *see* Reports, annual, of the director.
properties of materials, C28.
of molybdenite, S338.
pyrometers, S121.
pyrometry, S11.
rotation of sucrose in water solution, S52.
Ore analysis, S186, T8, C26.
see also Reports, annual, of the director.
Ores, iron and manganese, analysis, C26.
Organic acidity of oils, T223.
Orient coal, experimental-retort tests, T134.
Orifice meters for air, T183.
Ornamental glass, C164.
Oscillation detectors, S140, C74.
Oscillations, damped, source, S95, S140, S158, C74.
damping of, S289.
electrical, S95.
detectors of, S140.
in antennas, S157, S326.
in inductance coils, S326.
high frequency, S60.
undamped, produced by arc, S60.
electron tube, S355, C74.
Oscillatory interference bands, S150.
Oscillion, *see* Electron tubes.
Oscillograph, cathode-ray, S489.
measurements in automobile battery circuits, T186.
use in measurement of, S504.
Osmium arc spectrum, S499.
radiation constant, S105.
Output characteristics of electron tube generators, S355.
of rectifiers, T265.
Overfiring, effect upon clays, T22.
Overhead line rules for electrical workers, C49.
Oven, Koppers, for coking Illinois coal, T137.
Oxalate, sodium, standard, C25.
Oxidation, automobile cylinder oils, T73.
petroleum oils, S153, S160, T4, C99.
Oxide, determining aluminum as, S286.
iron, emissivity, S249.
leaded zinc, specifications, C88.
zinc, comments on, T274.
specifications, C87.
Oxides, emissivity, S224, S242, S243.
refractory, S212.

*For more specific reference see table of contents of the publication cited.

Oxidimetry, S182, C40.
indicators, S178.
sodium oxalate as standard, C25.
Oxyacetylene welding and cutting blowpipes, T200.
Oxygen content of acid Bessemer steels, S346.
determination, in steels, S350.
in iron and steel by Ledebur method, T118.
effect on red shortness of iron, T261.
in nickel, T281.
instruments (aircraft), T237.

P

Packing, C169.
asbestos high-pressure rod, C238.
metallic cloth sheet packing, C243.
flax, C239.
hosiery boxes, C169.
low-pressure spiral gland, C237.
rubber, cloth insertion, C236.
diaphragm, C240.
wire insertion, C234.
sheet, compressed asbestos, C241.
tucks, C233.
Packings and gaskets, rubber, C235.
Pads, surgical operating, C245.
Palladium arc spectrum, S499.
effect on determination of iridium, S483.
Paint, C165.
application, T274.
black, comments on, T274.
specification, C94.
flat interior lithopcne, specification, C111.
for integrating photometric sphere, S447.
green, comments on, T274.
green, specification, C97.
iron oxide, comments on, T274.
and iron-hydroxide, specification, C93.
materials, C69.
composite vehicle, specification, C102.
dryer, specification, C105.
gloss interior lithopone, C147.
leaded zinc oxide, specification, C88.
linseed oil, specification, C82.
mineral spirits, specification, C98.
ocher, specification, C91.
red lead, specification, C90.
turpentine, specification, C86.
white lead, specifications, C84, C85.
zinc oxide, specification, C87.
ready mixed and semipaste titanium-zinc, C215.
red enamel, comments on, T274.
specifications, applicability of, T274.
white, comments on, T274.
specifications, C89.
Paints and varnishes, L1.
emissive tests, T254.
mixed, comments on, T274.
tests, C45, M15.
see also Reports, annual, of the director.
Palladium, radiation and melting point, S55.
reflection, S45.
Pancake coils, inductance, S455.
Paper, T262.
asbestos, simplified practice in, R19.
bags for cement and lime, T187.
boxes, T253.
color of white, T244.
condensers, S166.
losses, S190.
fibers, T250.
finish of, T244.
making, T262.
specification for quicklime for use in causticizing, C143.
micrometers, T226.
pulp, limestone and quicklime for use in manufacture of sulphite pulp, C144.
pulps, T88.
unbleached sulphate and sulphite, T189.
sizes, simplified practice in, R22.
shot shells, loaded, R31.
stock recovered from waste paraffin paper, T87.
testing, T194, C45, C107.
tracing, transparency, C63.
see also Reports, annual, of the director.
Parabolic curves, S388.
reflector for directive transmission, S469.
Paraffin recovered from waste paraffin paper, T87.
solidification point, S340.
Paraffined paper condensers, S166.
Parallel coaxial circles, S138.
wire ammeters, S206.
wire system, use of, by Bureau of Standards, S491.
Parallellism of gauge blocks, S436.
Partition walls, S506.
Parts of locomotive-cylinders, T172.
Party-line telephone service, C112.
Paschen's method of equal ordinates, S162.
Patent survey, treatment of beet-sugar waste water, C145.
Paving, R4.
bricks, R1.
Pentane lamp, S216.
Perception of color versus brightness, S303.
Performance, modern high-speed steels, T228.
of rectifiers, T265.
tests of soap, T273.
Perikon detector, *see* Rectifier, contact.
Periodic table, metals of second group, S402.
variable, function of, S90.
Periodicals, radio, C122.
Permanent records, photomicrographs, T217.
Permanganate solution, standardization, C25.
Permeability, balloon fabrics, T113.
magnetic, temperature coefficient, S245.
of brass containing iron, T221.
rubber to gases, S387, T113.
tests of marble, T123.
textiles, T266.
to air, T266.
to water vapor, T266.
Permeable properties of Portland cement mortars and concretes, T3.
Permeameter, Fahy, S306.
Koepsel, S228.
Personnel, *see* Reports, annual, of the director.
Petroleum oils containing sulphur, T177.
density and thermal expansion, T77.
iodine number, T37.
national standard tables, C154.
oxidation, S153, S160, T4, T73, C99.
standard tables, C57.
Phase angle of transformers, S116, S130, S164, S211, S217, S233.
difference, condensers, S64, C36.
insulating materials, measurement, S471.
of electrical insulating materials, T216.
of insulating materials, T284.
paper condensers, S166.
of harmonics, effect upon acoustic quality, S127.
relations in transformers, S116.
Phenol type insulating materials, S352.
Phenolic insulating materials, T216, T284.
*Philippine Islands, weights and measures, M13.
Phosphomolybdate precipitate, T8.
Phosphorus in low-carbon, open-hearth steel, T203.
in steels containing vanadium, T24.
in wrought iron, T97.
Photo-electric cell, S319.
properties of molybdenite, S338.
sensitivity, bismuthinite, S322.
spectral, of silver sulphide, S344.
spectrophotometry by null method, S349.
Photo-electrical conduction of selenium and stibnite, S398.
investigations, S319, S322, S338, S344, S388, S398, S446, S451, S456, S462.
properties, negative and positive, S398, S462.
of molybdenite, S398.
sensitivity, S446, S451, S456.
tests, argentite, S398, S446.
barium (Case's cell), S462.
bismuthinite, S322, S344.
boulangerite, S322, S446.
bournonite, S451.
cuprous oxide, S462.
cylindrite, S322, S344.
galena, S344.
gallium, S322.
iodine, S462.
jamesonite, S322, S344, S462.
lead antimony sulphide, S462.
lead, halide salts of, S456.
miscellaneous preparations, S402.
molybdenite, S322, S338, S398, S462.
potassium hydride, S319.

*For more specific reference see table of contents of the publication cited.

Photo-electrical tests—Continued.
proustite, S412.
pyrargyrite, S451.
pyrites, S322, S344.
selenium, S319, S322, S338.
silver, halide salte of, S456.
silver nitrate, S462.
silver sulphide, S344, S398, S446.
stibnite, S322, S398, S446.
strontium (Case's cell), S462.
tellurium, S322.
thallium, halide salts of, S456.
thalofide (Case's cell), S380.
various substances, S322, S344, S398, S462.
Photographic action of charred paper, S454.
densities, microphotometer for, S385.
emulsions, sensitometry of, S439.
filter factors, S409, S439.
lenses, aberrations, S494.
materials, sensitivity to charred paper emanations, S454.
method of detecting changes in group of objects, S392.
plates, color sensitive, S422.
radiometry, S319.
spectrograph, S422.
use of objectives, T217.
Photographing projectiles in flight, T255.
stellar spectra, S318.
Photography of interference phenomena, S441.
Photometer, flicker, and equality-of-brightness, S299.
Martens polarization, S367.
Photometers, Matthews and Russell-Léonard, S12.
precision, scale and recording device, S144.
Photometric attachment of spectroscopes, S155.
comparison of glass screens and tungsten lamps, S277.
laboratory walls, S20.
test fees, C6.
units and nomenclature, S141.
Photometry, S49.
carbon lamps, S115.
gas-filled lamps, S264.
heterochromatic, S238.
integrating sphere, S447.
use of flame standards, S222.
see also Reports, annual, of the director.
Photomicrographs as permanent records, T217.
Photomicrography, T217.
of stained fibers, T217.
Physical changes upon heating hardened carbon steels, S396.
factors which determine the saturation of yellow tints, T92.
photometer, S303.
properties, T267.
aluminum and its light alloys, C76.
dental materials, T157.
materials, C101.
russet harness leather, T160.
quantities, derivatives, S331.
tests, commercial marbles, T123.
Physical tests, cotton yarns, T19.
motor-truck wheels, T150.
Pickers, cotton, T277.
calculations, T282.
Picnometer for determining density of molasses, T161.
Piers, brick, compressive strength, T111.
Piezo-electric method for measuring high pressures, S445.
Pigment, titanium, C163.
Pigments, effect on linseed oil, T71.
Pillowcases, rubber, C224.
Pillows, rubber air, C252.
Pima cotton, T277.
for mail-bag duck, T278.
Pin plates, behavior, T101.
Pipe threads, M42, M61.
Pipettes, glass, C9.
Pitch, coal-tar, C155, C157.
Pitches and diameters of screw threads, M42, M61.
of screw threads, M49.
screw thread, graphic comparison of, M49.
Pitting of copper, T90.
Plain lamps, S72.
Plain linoleum, C190.
Planck's constant C_2, S162, S287.
equation, Spectral distribution of energy by, tables and graphs, M56.
law, S259.
radiation equation, S204, S304.
Planeness of gauges, S436.
Planetary radiation, S244, S460.
Plaster, C151, C205, C206.
as fire protection for concrete columns, T272.
board, gypsum, C210.
colored, T181.
construction, durability, T70.
Plasters, plasticity, T169.
Plastic flashings, C181.
fire clays, European, T79.
flow, T234.
laws, S278.
Plasticity, clay, S278, T79.
clay, Atterberg method, T46.
measurement, T46.
mortars and plasters, T169.
Plasticity, methods of measuring, T234.
Plate circuit, load, S351.
drying cabinet, S422.
glass, C164.
iron and steel, gage, C18.
modulation, radiotelephony, S423.
Plates, photographic, American, characteristics of, S439.
color sensitive, S422.
*Platform scales, testing, M10.
Plating solutions, zinc cyanide, T195.
"black nickel," T190.
Platinum, arc spectrum of, S499.
black, electrolysis of, S82.
reflecting power, S196.
emissivity, S243.
metals, arc spectra of, S499.
point electrolytic detector, S36.
radiation, S24.
and melting point, S55.
constant, S105, S191.
radiometers, S322.
resistance thermometers, S407.
thermometry, S124.
volatilization, S280.
ware, quality of, S254.
Pliotron, C74.
see also Electron tube.
Plow bolts, R23.
Plugs, boiler, fusible tin, T53.
Plumbing, recommended minimum requirements for, BH2.
Pneumatic tires, specifications, C115.
Pocket spectrophotometer, S39.
Polarimetric sensibility and accuracy, S35.
Polarimetry, C44.
see also Reports, annual, of the director.
Polariscopic apparatus, testing, C12.
measurements, S34.
quartz compensating, S86, S98.
Polarity in wiring, H4.
Polarization, measurement of, S504.
Pole line mechanics, H4.
Poles, H3.
Politzer bags, rubber, C222.
Polygonal coils, inductance, S468.
Porcelain bodies high in feldspar, T50.
viscosity, T30.
constitution and microstructure, T80.
glazes, T196.
laboratory ware, tests, T105.
thermal expansion, S352.
Pore water of plastic fire clays, T79.
Porosity, burned clay, T22.
changes in burning silica refractories, T116.
clay fire bricks, T159.
of refractory bodies, T104.
tests of marble, T123.
Porous-cup voltameter, S194, S220.
Portable cubic-foot standard for gas, T114.
vacuum thermopile, S413.

*For more specific reference see table of contents of the publication cited.

Portland cement, T102.
calcium silicate and calcium aluminate in, T78.
crushing strength, T5.
Government specification, C33.
hardened with Cal, T174.
hydration, T43.
mortar and concrete, absorptive properties, T3.
properties, T102.
steam test, T47.
Porto Rico, weights and measures, M59, M55, M12.
Positive charges carried by canal rays, S23.
Potassium permanganate solution, S182.
Potential measurements, S364, T146.
transformers, regulation of, S129.
testing, S217.
Potentials, electrolytic measurements, S504.
ionization and resonance, S400.
ionization and resonance, for electrons in lead and calcium vapors, S368.
resistance and ionization, for electrons in cadmium vapor, S317.
Potentials, resonance, for metals of second group of periodic table, S403.
Potentiometer for accurate measurements, S33.
Potentiometers, deflection, S79, S172, S173.
testing, S223.
Pottery materials, ball clays, T227.
Poulsen arc, *see* Arc, high-frequency.
Poultry fence, R9.
Pouring tests of concrete, T175.
Powdered laundry soap, specification, C195.
Powder, smokeless, test, S192.
Power expended upon condensers and circuits, S18.
factor of condensers, S64.
factor of insulating materials, T284.
Power-loss, T240.
condensers, C36.
dielectric, S166.
electrical insulating materials, measurement, S471.
Power losses in automobile tires, T213.
plant at Bureau of Standards, *see* Reports, annual, of the director.
reflecting, of tungsten and stellite, S308.
resolving, of objectives, S122.
Poynting clamp, S482.
Practice, electrical, in mines, C23.
pyrometric, T170.
Precision colorimeter, S187.
measurements of resistance and emf, C21.
photometers, scale, and recording device, S144.
standard manufacture, M51.
tests of large capacity scales, T199.
Preliminary heat treatment of clays, S151, T1.
Preparation, chloroplatinic acid, S82.
galactose, S416.
of spectrum tubes, S441.
raffinose, S432.
mannose, S429.
silver nitrate, S201.
Press cloth, T231.
Pressure gauges (aircraft), T237.
measurements, C55.
regulation, S503.
tests of concrete, T175.
tests of steel tanks, T243.
vapor, of ammonia, S369.
variation of liquid ammonia, latent heat, S314.
Pressures, instantaneous measurement of, S445.
Primary mercurial resistance standards, S256.
radio-frequency standardization by use of the Cathode-ray oscillograph, S489.
standard wave-meters, S489.
wave-meter standardization, S489.
Primer, a zoning, BH3.
asphalt, C162.
Principles of radio transmission and reception, S354.
Printed linoleum, C190.
Printing inks, analysis, T39, C53.
composition, properties, testing, C53.
Prism glass, C164.
material, transmission, S191.
standard, S401.
Proceedings of second annual textile conference, M19.
Processed glass, C164.
Processes for the reclamation of gasoline, T280.
Producing high-frequency electrical oscillations, S95.
Production of high-frequency oscillations, S60.
Progress report of National Screw Thread Commission, M42.
Progressive fading, of radio signals, S476.
Projectiles, camera for studying, T255.
photographing, in flight, T255.
Promenade tile, C158
Propagation of long electromagnetic waves, S353.
Property, *see* Reports, annual, of the director.
Properties, American bond clays, T144.
ammonia, Mollier chart, M52.
tables and Mollier chart, C142.
arc-fused steel, T179.
calcium silicates and calcium aluminate in Portland cement, T78.
concretes, T58.
electric condensers, C36.
electrical, of silver sulphide, S310.
European plastic fire clays, T79.
gypsum, C108.
heat-insulating, of fire-resistive materials, T130.
high-speed steels, T 228.
insulating, of dielectrics, S234.
lime, C30.
luminous, of helium gas, S89, S176.
magnetic and mechanical, of steel, S272.
magnetic, of annealed eutectoid carbon steel, S408.
materials, C101.
mechanical, of rolled light alloys, T132.
pure iron and alloys, S453.
metals, C113.
of ammonia (chart), M57.
of ball clays, T227.
of fluids, S501.
of steels and irons, S433.
optical and photoelectric, of molybdenite, S338.
optical instruments, C27.
optical, of materials, C28.
photoelectric, of molybdenite, S398.
physical, of aluminum and its light alloys, C76.
of dental materials, T157.
of russet harness leather, T160.
Portland cement, T102.
mortars and concretes, T3.
printing inks, C53.
rails, T38.
reflected, of aluminum alloys with magnesium and zinc, S363.
sand-lime brick, T85.
spectral transmissive, of dyes, S440.
steel plates containing zirconium, T207.
tensile, boiler plate at high temperatures, T219.
tensile, of alloy steels, T205.
textile materials, C41.
thermoelectric, of tantalum and tungsten, S120.
wall plaster, C151.
white metal bearing alloys, T188.
wire rope, T121.
Protected thermoelements, S276.
Protecting against lightning, T56.
eyes from injurious radiations, T93.
heads and eyes of industrial workers, H2.
Protective metallic coatings for rustproofing, C80.
Prototype meter, recomparison, S1.
Proustite, spectrophotoelectrical sensitivity, S412.
Public relations, telephone companies, C112.
utility service standards, C68.
utilities, grading of, M58.
Publications issued, *see* Reports, annual, of the director.
of the Bureau of Standards, C24.
radio, C122.
Pulps, paper, T88.
*Pumps, liquid measuring, T81, M14, M41, M43. M48.
Purchase, *see* Annual reports of the director.
Purchases, C55, M45.
Pure color, natural scale of, S118.
iron alloys, S266, S453.
electrical resistance and critical ranges, S236.
Purification, composition and certain constants of ammonia, S465.
of water, lime for use in, C231.
Purifying clays with sodium salts, T51.
materials for standard cells, S70.

*For more specific reference see table of contents of the publication cited.

Purity of light sources, S44.
Putty, specifications for, C216.
Pyrargyrite, S451.
Pyrheliometer, Marvin, S323.
Pyrites, ultra-violet reflecting power, S493.
Pyrometer color screens, S260.
  testing, C7.
  tubes, T196.
Pyrometers, metals for standardizing, C25.
  optical, S121.
  radiation, S250.
Pyrometric practice, T170.
Pyrometry, optical, S11.
  see also Reports, annual, of the director.
Pyroxylin plastics as affected by heat, T98.

Q

Qualitative tests for gum arabic, T67.
Quality of speech transmission, telephony, C112.
  standards for public-utility services, C68.
Quantitative determination of gum arabic, T67.
  experiments in radiotelegraphic transmission, S159, S226.
    with silver voltameter, S194, S201, S220.
  study of regeneration by inductive feed back, S487.
Quantities, physical, derivatives, S331.
Quantity, electric, measurement of, S139.
Quartz, absorption, reflection, and dispersion constants, S237.
  and sucrose dispersion ratio, S268.
  compensating polariscope, S86, S98.
  dispersion ratio, S34.
  fibers, elastic properties, S7.
  glass, infra-red spectral reflection, S168.
  mercury vapor lamp, component radiations, S378.
    vapor lamps, S330.
  reflection, S45.
  rock salt spectrograph, S441.
  spectroradiometers, S401.
  temperature coefficient, S34, C44.
  use as condenser insulation, C74.
  wedge saccharimeter, constants, S268.
Quick setting cement affected by Cal, T174.
Quicklime, C153, C201.
  for cooking paper rags, C96.
  for glass manufacture, specification, C118.
  for use in causticizing, C143.
  for use in manufacture of sulphite pulp, C144.
  for use in the purification of water, C231.
  recommended specification for, for use in the manufacture of calcium arsenate, C203.
  recommended specification for, for use in the manufacture of sugar, C207.

R

Radiant energy, measured in absolute value, S261.
  spectral distribution of energy by Planck's equation, tables and graphs, M56.
  visibility of, S475.
Radiating disk, illumination from, S263.
  surfaces, S51.
Radiation, S8, S11, S162, S180, S198, S205, S224, S242, S243, S249, S250, S259, S260, S263, S270, S317, S354, C7, C74.
  constants, S357.
    calculation, S284.
    metals, S105.
    platinum, S191.
  data, computing and intercomparing, S360.
  decreasing and increasing, T254.
  equation, Planck's, S304.
  from antennas, S354.
    black body, S262, S305, S357, S406.
      horizontal coil antennas, S431.
    paints, T254.
  palladium and platinum, S55.
  platinum, S24.
  quartz mercury vapor lamps, S330.
  sun and carbon arc lamp, S330.
    and quartz mercury vapor lamp, S378.
  laws of metals, S152.
  luminous equivalent, S103.
  method for determining melting points, S62.
  methods of measuring, T254.
  of stars, S438.
Radiation—Continued.
  pyrometers, S250.
  resistance of antenna, S257.
  selective, S91, S97, S131, S156, S191.
    of incandescent lamps, S40.
  solar, effect upon balloons, T128.
  spectral, constants, S204, S284.
  standards, S227, S262.
  stellar and planetary, S244, S438, S460.
  visibility of, S154.
Radiations injurious to eyes, protection from T93.
Radiator core, investigations, T211.
Radiators, S406.
Radiators for aircraft engines, T211.
Radio, S477.
  beacon, S480.
  classification, C138.
  communication, S235, S269, S326, S341, S351, S353, S354, S355, S381, S423, S427, S428.
  see also Reports, annual, of the director.
  compass, S428.
  direction finders, S428.
  electron-tube detector for, C133.
  fading, S476.
  frequency ammeters, S206.
  amplification, S449, S450.
    phase difference of insulating materials, T284.
    resistance, S169.
    properties, insulating materials, measurement, S471.
    standardization, S489.
    inductance of coils used in, S468.
    information, sources, C122.
    instruments and measurements, C74.
    publications, C122.
    receiving outfit, simple, construction of, C120.
      condensers and loading coil for, C137.
      set, amplifier, C141.
      sets, C121.
  receiving sets, methods of testing, T256.
  regulations, C122.
  Service Bulletin, C122.
  transmission and reception with antenna and coil aerials, S354.
    formula, S226.
  transmitting set, use with coil antenna, S480.
  transmitting sets, electron tube, S381.
  waves, variation in direction, S353.
Radioactivity, *see* Reports, annual, of the director.
Radiobalance, Callendar, S188.
Radiometer, S85.
Radiometers, gold leaf, platinum, and selenium, S322.
  selective, S319.
  stellar, S244.
Radiometers, stellar, S188, S229, S244, S438, S460.
Radiometric investigations, S168.
  of spectra, S45.
  measurement on stars, S244.
Radiometry, instruments and methods, S85, S188, S319.
  see Reports, annual, of the Director.
  stellar, S438.
Radiomicrometer, S85, S156.
  vacuum, S46, S188.
Radiotelegraphic antenna, field, S269.
  antennas, S257, S269, S326, C74.
    resistance, S257.
  transmission, S226, S354.
Radiotelegraphy, frequency, S96.
  long distance, S159.
Radiotelephone sets, use of modulator tube, S423.
Radiotelephony, C112.
  modulation, S423.
Radius, equivalent, polygonal coils, S468.
Raffinose, preparation of, S432.
Rag felt, asphalt saturated, C161.
  coal tar saturated, C156.
Rags for wiping, colored cotton, C261.
  white cotton, C264.
Rail ingots, ordinary, T178.
  joints and bonds in electric railways, T62.
  steel, titanium and silicon deoxidation of, T241.
*Railroad track scales, M13, M14, M41.
  track scales, design, M9.
    specifications, C83.
Rails, finishing temperatures and properties, T38.
  foreign specifications, T61.
  steel, from sink-head and ordinary ingots, T178.

*For more specific reference see table of contents of the publication cited.

Railways, electric, construction and maintenance, T62.
current leakage, T63.
leakage resistance of roadbeds, T127.
track leakage, T75.
materials, foreign specifications for, T61.
Ranges, critical, of nickel steels, S376.
Rare earth elements, preparation, S421.
Rare earths, S466.
Rasps and files, simplified practice in, R6.
Rate-of-climb indicators, T237.
Rate of cooling related to properties of carbon steel, S408.
exhaustion by reciprocating air pump, T224.
of sulphation, T225.
of temperature change, effect on transformations in steel, S335.
of vitrification of clays, T79.
Ratio of electromagnetic to electrostatic unit of electricity, S65, S66.
of transformation in transformers, S116.
of transformers, S211.
Raw materials for silica refractories, T116.
wools, weight, T57.
Rays, canal, S23.
Reactance, leakage, transformers, S455.
Ready-mixed plaster, C205.
Ready-mixed and semipaste, titanium-zinc paint, C215.
Reagents, etching, for copper, S399.
in colorimetric determination of iron, S53.
metallographic etching, S435.
see Reports, annual, of the director.
Received current, radio, measurement, S159, S226.
Receiving antenna, S157, S354, C74.
oscillations in, S157.
Receiving set, amplifier for, C141.
condensers and loading coil for, C137.
sets, radio, C121.
Reception of radio on airplane, S480.
Reciprocating air pump, rate of exhaustion by T224.
Reclaimed oils, T223.
Reclamation of gasoline, T280.
Recommended minimum requirements for masonry wall construction, BH6.
for plumbing in dwellings and similar buildings, BH2.
for small-dwelling construction, BH1.
Recomparison of prototype meter, S1.
Recording and computing machine ribbons, specifications for, C188.
device for precision photometers, S144.
instruments (aircraft), T237.
Records, permanent, photomicrographs, T217.
* Records, weights and measures, M10, M13.
Recovering paraffin and paper stock from waste paraffin paper, T87.
toluol, T117.
Recrystallization of metals as affected by cold work, T60.
Rectangular areas, geometrical mean distances of, S47.
Rectification, T265.
Rectifier, contact calibration by thermoelement, S140, C74.
see also Detector, electrolytic.
Rectifiers, T265.
contact, S94, S140, S157, S158, C74.
of electric currents, S94.
Rectifying effects in conducting gases, S6.
Red and infra-red spectra, S372, S411, S421
Red, enamel, C146.
United States specification for, C146.
hardness, high-speed steel, S395.
ink, specification for, C184.
lead, comments on, T274.
specifications, C90.
shortness of iron, T261.
Reduction of varieties of fences, R9.
Redwood viscometer, T210.
Refining oils, T223.
Reflected properties of aluminum alloys, with magnesium and zinc, S363.
Reflecting power, lampblack and platinum black, S196.
metals, S152.
monel metal, stellite, and zinc, S379.
pyrites, stibnite, molybdenite, galena, graphite, duralumin, S493.
stellite and lacquered silver, S342.
substances, S196.
tungsten and stellite, S308.
variations with angle of incidence, S196.
Reflection coefficient of electrical waves, S114.
constants of quartz, S237.
diffuse, S261.
factors, S391.
absolute measurement, S405.
measured by Ulbricht sphere, S415.
of aluminum, palladium, cadmium, iridium, quartz, and carborundum, S45.
of radio waves, S476.
of very short electric waves, S469.
spectra, S45.
total and spectral, of Munsell color standards, T167.
white surfaces, S447.
Reflectometer, absolute, S391.
Refraction data on standard optical materials, S401.
of radio waves, S476.
Refractive index of air, S327.
indices, rock salt, S418.
Refractometer, gas, S316.
Refractories, C153.
clay, testing, T7.
silica, T116.
see Reports, annual, of the director.
Refractory bodies, strength, T104.
clays, T79.
elements, melting points, S205.
oxides, S212.
Refrigeration, S501.
machines, ammonia absorption, T180.
Regeneration, S487.
Regulating electrotyping solutions, C52.
potential transformers, S129.
transformers, S211.
utilities, C112.
Regulation of flow, S503.
of temperature, S503.
Regulations authorized by Federal standard barrel law, C71.
for enforcing lime barrel act, C64.
for testing glass volumetric apparatus, C9.
mass standards, C3.
timepieces, C51.
measuring apparatus, C2.
radio, C122.
Reheat factor, S167.
Reinforcing bars, steel, R26.
Reinforced concrete beams, T2.
building test, T236.
test of, T220.
columns, fire resistance of, T272.
tests, T122.
Relative sensibility of "average eye," S303.
spectral transmission of the atmosphere, S389.
wave lengths, S142.
wear of sole leathers, T147.
Reluctivity relationship, magnetic, S404.
Remote control system for electric testing laboratory, S291.
Repeated burnings of silica brick at high temperatures, T124.
Repeating coils, C112.
Reports:
report of visiting committee, M63.
Proceedings of the Second Annual Textile Conference held at the Bureau of Standards (1917), M19.
Progress report of the National Screw Thread Commission, M42.
Report of the National Screw Thread Commission, 1924, M61.
Report of building code committee, BH1, BH2, BH6, BH7.

*For more specific reference see table of contents of the publication cited.

Reports—Continued.
Report of committee on zoning, BH3, BH5.
Reports (Annual) of the director of the National Bureau of Standards for fiscal years ending June 30:
1902, M22.
1903, M23.
1904, M24.
1905, M25.
1906, M26.
1907, M27.
1908, M28.
1909, M29.
1910, M30.
1911, M31.
1912, M32.
1913, M33.
1914, M34.
1915, M35.
1916, M36.
1917, M37.
1918, M38.
1919, M40.
1920, M44.
1921, M47.
1922, M50.
1923, M53.
1924, M60.
Reports of Annual (National) Conferences on the Weights and Measures of the United States for year:
First, 1905, M4.
Second, 1906, M5.
Third, 1907, M6.
Fourth, 1908, M7.
Fifth, 1910, M8.
Sixth, 1911, M9.
Seventh, 1912, M10.
Eighth, 1913, M11.
Ninth, 1914, M12.
Tenth, 1915, M13.
Eleventh, 1916, M14.
Twelfth, 1919, M41.
Thirteenth, 1920, M43.
Fourteenth, 1921, M48.
Fifteenth, 1922, M51.
Sixteenth, 1923, M55.
Seventeenth, 1924, M59.
Report to the International Committee on Electric Units, M16.
Requirements, minimum, for small-dwelling construction, BH1.
Reproducibility of luminous properties of helium gas, S176.
Residual induction varying with magnetizing force, S384.
Resin in drier, T66.
in varnish, T65.
Resistance, airplane antenna, S341.
alternating-current, of conductors, S374.
of solenoids, S472.
antenna, S189, S257, S269, C74.
coils for alternating currents, S177.
measuring inductances, S175.
copper, temperature coefficient, S147.
coupling, S449.
earth, related to electrolysis of underground structures, T26.
effective, of iron wires, S236, S252.
skin effect. S169, S252, S374, S430, C74.
high-frequency, S169.
high-frequency, inductance coils, S430.
inductance coils, S430.
iron and bimetallic wires, S252.
leakage, of street-railway roadbeds, T127.
measurement, S111.
by decrement method, S189, C74.
precise, C21.
measurements, S481.
oil to emulsification, T86.
of batteries, S504.
of tires, effect on fuel consumption, T283.
potentials for electrons in cadmium vapor, S317.
radio-frequency, measurement, S471.
radio-frequency, polygonal coils, S468.
radiotelegraphic antennas, S257.
rolling, of tires. C198.
solenoidal coils, S76.
Resistance, airplane antenna—Continued.
standard, S107.
standards, four-terminal, S281.
mercurial, S256.
thermometers, S68, S294.
calorimetric, S200.
platinum, S407.
thermometry, S241.
apparatus, S288.
platinum, at high temperatures, S124.
to corrosion of rolled light alloys, T132.
variation method, radio measurments, S471.
windage, of steam-turbine wheels, S208.
Resistances, low, measurement of, S225.
variation of, S73.
Resistivity, earth, measurements, S258.
Resistivity of electrical insulating materials, T216.
insulating materials, measurement, S471.
relation to total emissivity, S243.
Resolving power of objectives, S122.
Resonance indicator, improved type for wave meter, S502.
phenomena, C74.
potentials for electrons in lead and calcium vapors, S368.
for metals of second group of periodic table, S403.
of six nonmetallic elements, S400.
radio circuits, S235, C74.
sharpness of, S158.
Reversals of stress on concrete beams, T182.
Restaurant and cafeteria chinaware, R33.
chinaware, C202.
Retail standards, C149.
Rhodium, arc spectrum of, S499.
effect on determination of iridium, S483.
Ribbons, C95.
computing and recording machine, specification for, C188.
hectograph, specification for, C187.
typewriter, specification for, C186.
Ring cushions, cloth-inserted, C254.
rubber ring, C246.
Ring specimens, S108.
Rings, veritas firing, T40.
Riveted tanks, stresses in, T243.
Rock salt, quartz, spectograph, S441.
refractive indices, S418.
spectroradiometers, S401.
Rods, lightning, T56.
straight, magnetic testing, S361.
Roller bearings, friction and carrying capacity, T201.
Rolling, T267.
Roofing, asphalt for mineral surfaced, C159.
asphalt for unsurfaced built-up, C168.
asphalt primer for, C162.
asphalt-saturated rag felt for, C161.
built-up, metal flashings for, C180.
built-up, plastic flashings for, C181.
coal-tar saturated rag felt for, C156.
coal-tar pitch for, C157.
prepared, asphalt for, C192.
slate, simplified practice in, R14.
specification for surfacing materials for bituminous built-up, C158.
type 3ACS, C172.
type 4ACS, C173.
type 5ACS, C174.
type 4AWS, C170.
type 5AWS, C171.
type 3TCS, C175.
type 4TCS, C176.
type 5TCS, C177.
type 4TWS, C178.
type 5TWS, C179.
Rope, formula for strength, T198.
manila, tests, T198.
wire, C208.
wire, properties, T121.
Rosa inductance formula, S169.
Rosenhain furnace, modified, S348.
Rotating lamp method, S43.
sectored disk, S26.
Rotation of fucose, S459.
of sucrose, S268.
optical, of sucrose, S52.
specific, of dextrose, S293.

*For more specific reference see table of contents of the publication cited.

Rotary dispersion method for measurement of color temperature, S443.
Round wire, polygons, inductance, S468.
Rubber air pillows, C252.
analysis, T45, T64, T136, T145, T154, T162, C38.
aprons, surgeons', C247.
bandages, C219.
catheters, C225.
colon tubes, C221.
dams, C218.
determining sulphur in, T45.
diaphragm packing, C240.
direct determination, T35.
finger cots, C226.
fountain syringe, C251.
friction tape, C229.
gloves, surgeons', C217.
goods, cellulose in, T154.
determining barium carbonate and barium sulphate in, T64.
extraction, T162.
free carbon in, T136.
general specification for, C232.
testing, C38.
hot water bottles, C248.
ice bag, helmet-shaped, C228.
ice bags, C227.
india, S174.
insulated tape, C230.
lined fire hose, C114.
packing, cloth insertion, C236.
packing, wire insertion, C234.
packings and gaskets, C235.
permeability, T113.
to gases, S387.
physical testing, C38.
pillowcases, C224.
politzer bags, C222.
ring cushions, C246.
sheeting, C253.
sulphur in, analysis, S174.
surgical operating pads, C245.
tests, C38, C45.
tips, crutch, C223.
tubing, T133.
valves, C244.
see Reports, annual, of the director.
Rules authorized by Federal standard barrel law, C71.
electrical, H3.
elevator, T202.
eye protection, H2.
Runge's method for analysis for alternating-current curves, S203.
Russet harness leather, physical properties, T160.
Rust-preventive compound, C200.
medium and light, C214.
Rustproofing iron and steel, C80.
Ruthenium, arc spectrum of, S499.
effect on determination of iridium, S483.

S

Saccharimeter, quartz-wedge, constants of, S268.
Saccharimetric normal weight, S293.
Saccharimetry, standard sample of sucrose, C25.
Safety at sea, use of radio-direction finder, S428.
by grounding electrical systems, T108.
Safety code for logging, H5.
code for sawmill, H5.
code, head and eye protection, H2.
national electrical, C54, H3, H4.
for protection of heads and eyes of industrial workers, H2.
scope and application, C72.
engineering, *see also* Reports, annual, of the director.
for the household, C75.
in aerial and marine navigation, S480.
of oxyacetylene blowpipes, T200.
precautions, lightning, T56.
rules for operation of electrical equipment and lines, C49.
standards for public utility services, C68.
Sagger bodies, T104.
Sag of line conductors, H3.
Salts, sea and alkali water, effect upon cements, T12.
Samarium arc spectra wave lengths, S442.
Samples, standard, for thermometric fixed points. C66.
general information, C25.
Sand blasting, T142.
Sand-lime, C150.
brick, T251.
description and specification, C109.
manufacture and properties, T85.
walls, compressive strength, T276.
Saturation of tints of yellow, T92.
relations in sugar mixtures, T259.
Sawmill Safety Code, H5.
Saybolt universal viscosimeter, T100, T112.
viscosity of blends, T164.
Scale, Baumé, for sugar solutions, T115.
natural, of pure color, S118.
temperature, S143.
temperature, standard, S69.
volt, S113.
weighing, with stabilized platform, T106.
Scales, C61.
*automatic, M13, M41.
Baumé hydrometer, C59.
*creamery, M12.
*design and construction, M11.
investigation and testing, *see also* Reports, annual, of the director.
jewelers, M12.
large capacity, tests, T199.
*mine, M41, M48.
prescription, M12.
*platform, testing, M10.
*plumb and level conditions in, M12.
*railroad track, M13, M14, M41.
*railroad track, design, M9.
railroad track, specifications, C83.
Scales, M55, M59.
creamery, M55, M59.
specifications for hand-operated grain hopper scales, C199.
Scientific literature relating to helium, C81.
Scleroscope hardness, T11.
Scouring, wool fleece and mohair yarns, T273.
Scratch coat, C205.
Screen, luminosity, S303.
shielding, radio measurements, S471.
Screens, color, pyrometer, S260.
glass, compared with tungsten lamps, S277.
see also Sieves.
Screw Thread Commission, 1924 report, M61.
progress report, M42.
gauges, M42, M61.
pitches, M49, M61.
threads, M42.
thread diameters, C140, M42, M61.
pitches, graphic comparison of, M49.
tap drill sizes, M61.
taps and cutting tools, M61.
tolerances, M42, M61.
Screws, measurements, C2, M61.
wood, Government specifications, C140, M61.
Sea water, effect upon cements, T12.
annual conferences, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M41, M43, M48, M55, M59.
*state, functions, M11, M41, M48.
weights and measures, M1, M4.
*Sealing, methods of, M11.
weights and measures equipment, M1.
Seams, tests, T96.
Searchlight arcs, high-tensity, T168.
"Season cracking" of brass, T82.
Season, effect on phenolic insulating materials, T284.
Seasonal variation, of radio signals, S476.
Secant formula, T258.
Second annual textile conference, M19.
Secondary hardening of high-speed steel, S395.
spectra, S5.
Sectored disk, S26, S156, S319.
Selection of fundamental electrical units, S102.
Selective radiation, S97, S131, S156, S191.
from Nernst glower, S91.
of incandescent lamps, S40.
Selectivity, measurement of, radio receiving sets, T256.

*For more specific reference see table of contents of the publication cited.

Selenium, S338.
cell, S319.
photo-electrical conduction, S398.
properties, S319, S322, S338.
radiometers, S322.
Self inductance, S93, S169.
calculation, S47, S93, S169, S320, C74.
circles, S75, S169.
coil of any length, S83, S169.
coils, S31, S37, S169, C74.
conductors, S80.
formulas, S169, S320.
and tables for, S468.
polygonal coils, S468.
single-layer coils, S31.
solenoid of any number of layers, S84, S169.
toroidal coil of rectangular section, S74, S169.
inductor, variable, S290.
Semipaste and ready mixed titanium-zinc paint, C215.
Sensibility, adjustable, of polariscope, S86, S98.
of eye, S49, S303, S366, S475.
polarimetric, S35.
Sensitiveness, detectors of electrical oscillations, S140, C74.
Sensitivity, measurement of, radio receiving sets, T256.
of photographic materials to charred paper emanations, S454.
photo-electrical, S446, S451, S456.
spectrophoto-electrical, S446.
photo-electrical, of bismuthinite, S322.
spectral photo-electric, of silver sulphide, S344.
spectrophoto-electrical, of proustite, S412,
tests of Thomson galvanometer, S282.
thalofide, S380.
Sensitizing photographic plates by bathing, S422.
Sensitometry of photographic emulsions, S439.
Separators, storage battery, T271.
Serialization law in Pennsylvania, M51.
Series in molybdenum, S474.
Serpentine standards of inductance, S15.
Service from domestic gas appliances, C116.
standards, electric, C56.
gas, C32.
of quality and safety, C68.
telephone, C112.
Set, generator, S25.
permanent, of sand-lime brick walls, T276.
Setting of a mercury surface, S214
Sextants, marine, specifications, C110.
Sharpness of resonance, S158.
Sheaves, effect on wire rope, T229.
Sheet, current, inductance calculations, S169.
iron and steel, gauge, C18.
enamels for, T165.
packing, asbestos, metallic cloth, C243.
compressed asbestos, C241.
steel, R28.
Sheeting, rubber, C253.
Shellac, source and manufacture, T232.
specifications, T232.
testing, T232.
Shells, loaded paper shot, R31.
Shenandoah, T270.
Shielding, radio-measuring circuits, S471.
Shipment, weight, space, and packing, C77.
Shipping cases, hosiery, C169.
Short bars, apparatus for determining magnetic properties of, S458.
life of frosted lamps, S61.
Short-time fatigue tests, T275.
intervals, S470.
Short wave directive transmission, S469.
Short waves, susceptibility of fading, S476.
Shot shells, loaded paper, R31.
Shrinkage by laundering, T273.
of fire clays, T79, T144.
refractory bodies, T104.
Sieves, cement, standard, T29.
standardization, T42.
cloth for, C39.
manufacture, C39.
measurement, C39.
specifications, C39.
standard cement, T29.
standard cement for testing, C25.
specifications and measurements, C39.
standardizing, T42.
testing, C39.
Signal intensity measurement, C74.
line operation, C49.
radio, effect of fading, S476.
strength, variation of, S476.
Silica, C153.
brick, constitution and microstructure, T124.
refractories, T116.
Silicon, as a deoxidizer of rail steel, T241.
detector, S94.
rectifier, S94, C74.
reflecting power, S152.
Silver, S456.
arc spectrum, S411.
coulometer, S16.
deposits, S195.
lacquered, reflecting power, S342.
nitrate, preparation and testing, S201.
photo-electrical properties of halide salts of, S456.
sulphide of, S344, S398, S446.
reflecting power, S196.
sulphide, electrical properties, S310.
spectral photo-electric sensitivity, S344.
voltameter, S2, S27, S102, S171, S194, S195, S201, S218, S220, S240, S283, M16.
deposits, inclusions, S271.
proposed specifications, S285.
Silk waste, T268.
Similarity, dynamical, S394.
Simple electron-tube detector, C133.
radio-receiving outfit, C120.
sets, C121.
Simplification of sizes of bedsteads, R2.
brick, paving, R1.
commercial practice, R1, R2.
mattresses, R2.
paving brick, R1.
screw threads, M42, M61.
springs, bedstead, R2.
of wood screws, C140, M61.
Simplified practice in asbestos paper and asbestos millboard, R19.
in bed blankets, R11.
in hollow building tile, R12.
in face and common brick, R7.
in files and rasps, R6.
in forged tools, R17.
in hotel chinaware, R5.
in lumber, R16.
in metal lath, R3.
in milk bottles and milk-bottle caps, R10.
in paper sizes, R22.
in range boilers and expansion tanks, R8.
in roofing slate, R14.
what it is and what it offers, RXI.
Single layer coils, S31.
polygonal coils, S468.
self-inductance, S31, S169, C74.
Single-tier steel lockers, R35.
Sink-head ingots, T178.
Sink traps, brass lavatory and, R21.
Size of hosiery, C149.
Sizes in wire gages, C67.
of paving bricks, bedsteads, mattresses, springs, etc., R1, R2.
of rolls of fencing (packages), R9.
Skin effect, S76, S169, S252, S374, C74.
coils, S76.
electrical resistance, S430.
inductance coils, S430.
return circuit, S374.
wires, S252.
Slab beams reinforced diagonally, T233.
hollow tile and reinforced concrete, test, T236.
test of tile and concrete floor, T220.
Slabs, hollow tile and concrete, tests of, C261.
Slag, C158.
Slate, C158.
blackboard, R15.
roofing, simplified practice in, R14.
structural, R13.
Slushing oil, C200.
Slushing oils, T176.
Smokeless powder, T98.
test, S102.
Soap, T273.
automobile, laboratory examination, C127.
sampling, C127.
specification, C127.
bubbles, bullets going through, S508.

*For more specific reference see table of contents of the publication cited.

Soap—Continued.
chip, laboratory examination, C128.
sampling, C128.
specification, C128.
discussion of specifications for, C62.
general composition and varieties, C62.
grit cake, laboratory examination, C130.
sampling, C130.
specification, C130.
hand grit, laboratory examination, C132.
sampling, C132.
specification, C132.
liquid, laboratory examination, C124.
sampling, C124.
specification, C124.
laundry, laboratory examination, C193.
sampling, C193.
specification, C193.
method of testing liquid laundry, T273.
milled toilet, laboratory examination, C194.
sampling, C194.
specification, C194.
ordinary laundry, laboratory examination, C129.
sampling, C129.
specification, C129.
powder, laboratory examination, C125.
sampling, C125.
specification, C125.
powdered laundry, laboratory examination, C195.
sampling, C195.
specification, C195.
requirements of liquid laundry soap, T273.
salt water, laboratory examination, C126.
sampling, C126.
specification, C126.
scouring compounds, laboratory examination, C131.
sampling, C131.
specification, C131.
testing, specifications and methods, C62.
white floating, laboratory examination, C123.
sampling, C123.
specification, C123.
Soaps, testing, M15.
Sodium bismuthate method, S186.
oxalate, S182.
as a standard in volumetric analysis, C40.
hydrolysis of, S178.
salts used in purifying and casting clays, T51.
sulphate, transition temperature, S68.
Softening temperature of clays, T79.
Soft X rays from arcs in gases and vapors, S425.
Soils, alkali, effect upon cement draintile, T44, T95.
effect upon concrete, T95.
Solar radiation, effect upon balloons, T128.
Solders for aluminum, C78.
Soldiers metric manual, M21.
Sole leather, chrome and vegetable, durability, C198.
durability, T215.
wearing quality, T138.
Sole leathers, chrome and vegetable, T286.
relative wear, T147.
Solenoidal coils, resistance and inductance, S76, S169, C74.
Solenoids, alternating-current, resistance and inductance of, S472.
circular, inductance, S468.
coaxial, mutual inductance, S58, S59, S169, C74.
inductance, S455.
self-inductance, S84, S169, C74.
square, inductance, S468.
Solid dielectrics, S234, S352.
insulating properties, S234.
tires, specifications, C115.
Solidification points of naphthalene and paraffin, S340.
Solids, radiation from, S97.
selective radiation from, S131.
Solubilities of sucrose and dextrose in sugar mixtures, T259.
of dextrose in water, S437.
Solutions, calcium chloride, specific heat, S135.
electrotyping, C52.
plating, "black nickel," T190.
zinc cyanide, T195.
Sound, S506.
intensity measurements, S473.
proof tiles, T120.
see Reports, annual, of the director.
Sources, monochromatic light, S44.
Spaced windings, inductance coils, S455.
Spar varnish, specification, C103.
Spark, frequency in radiotelegraphy, high, S96, C74.
photography and ballistics, S508.
plug electrode cements, T155.
electrodes, nickel, T143.
spectra, S505.
Special reports of bureau's work, *see* Reports, annual, of the director.
Specific gravity, C16,
alcohol, C19.
balance for gases, T89.
burned clay, T22.
in burning silica refractories, T116.
petroleum oils, C59, C154.
sugar, C19.
solutions, T115.
sulphuric acid, C19.
tests of marble, T123.
water, C19.
heat, S501.
calorimeter for, S301, S503.
copper, S231.
ice, S248.
liquid ammonia, S313.
saturated vapor of ammonia, S315.
some calcium-chlorine solutions, S135.
water, S247.
inductive capacity, C74.
rotation, dextrose, S293.
for galactose (α=5462A), S416.
of fucose, S459.
sucrose, S268.
volume of liquid ammonia, S420.
volume saturated ammonia vapor, S467.
Specifications:
miscellaneous—
automatic scales, M51.
constructing weights, C3.
crossing construction, H3, H4.
cutting tools, M61.
elevator interlocks, T202.
factors determining saturation of yellow tints, T92.
flint-lime glass tumblers, C119.
foreign, for railway materials, T61.
gas, volumetric apparatus, C9.
glass volumetric apparatus accepted for test, S92.
gypsum, C108.
hose couplings, C50, M42, M61.
hydrometers, C16.
illuminating gas, T14.
lime—definitions and specifications, C106.
loading, H4.
measuring apparatus to be tested, C2.
ordinary laundry soap, C129.
paint, applicability of, T274.
paper bags for cement and lime, T187.
pipe threads, M42, M61.
primary batteries, C79.
proposed for silver volta meter, S285.
rubber products, C38.
sand-lime brick, C109.
screw threads, M42, M61.
slushing oils, T176.
special grade laundry soap, C62.
specification and tests for the transparency of paper and tracing cloth, C63.
for and method of testing soaps, C62.
specifications and tolerances for weights and measures and weighing and measuring devices, C61, H1. *See also* Reports, annual, Conferences on Weights and Measures.
for and measurements of standard sieves, C39.
for hand-operated grain hopper scales, C199.
for marine sextants, C110.
for the manufacture and installation of railway track scales, C83.
standard cells, S67.

*For more specific reference see table of contents of the publication cited.

Specifications—Continued.
miscellaneous—Continued.
standard specifications for transformers, oil-immersed, self-cooled, 60-cycle, 2,200-volt, C22.
timepieces, C51.
transformers, C22.
weighing and measuring devices, C61, H1. *See also* Reports, annual, of Conferences on Weights and Measures.
recommended specification for—
ceramic whiting, C152.
limestone and quicklime for use in the manufacture of sulphite pulp, C144.
limestone, quicklime, and hydrated lime for use in the manufacture of glass, C118.
limestone, quicklime, lime powder, and hydrated lime for use in the manufacture of sugar, C207.
quicklime and hydrated lime for use in the absorption of carbon dioxide, C189.
for use in the cooking of rags for the manufacture of paper, C96.
for the manufacture of silica brick, C153.
for use in the manufacture of calcium arsenate, C203.
for use in the purification of water, C231.
for use in the manufacture of sand-lime brick, C150.
quicklime for use in causticizing, C143.
United States Government master, for—
asbestos high-pressure rod packing, C238.
asbestos metallic-cloth gaskets, C242.
asbestos metallic-cloth sheet packing, C243.
asphalt for mineral-surfaced roofing, C159.
asphalt for unsurfaced built-up roofing, C168.
asphalt for waterproofing and damp proofing, C160.
asphalt prepared roofing, C192.
asphalt primer for roofing and waterproofing, C162.
asphalt-saturated rag felt for roofing and waterproofing, C161.
asphalt varnish, C104.
automobile soap, C127.
basic carbonate white lead, dry and paste, C84.
basic sulphate white lead, dry and paste, C85.
battleship linoleum, C191.
black paint, semipaste and ready-mixed, C94.
black waterproof drawing ink, C196.
brown denim (shrunk), C256.
brown denim (unshrunk), C259.
calcined gypsum, C206.
cheesecloth, bleached or semibleached, C257.
cheesecloth for wiping purposes, C255.
cheesecloth, unbleached, C258.
chip soap, C128.
cloth-inserted fountain syringe, C250.
cloth-inserted hot-water bottle, C249.
cloth-inserted ring cushions, C254.
cloth-insertion rubber packing, C236.
coal-tar pitch for roofing, C157.
coal-tar pitch for waterproofing and damp proofing, C155.
coal-tar saturated rag felt for roofing and waterproofing, C156.
colon tube, C221.
colored cotton rags for wiping machinery (sterilized), C261.
composite vehicle for thinning semipaste paints when the use of straight linseed oil is not justified, C102.
compressed asbestos sheet packing, C241.
computing and recording machine ribbons, C188.
construction of built-up roofing, type 3ACS, C172.
type 4ACS, C173.
type 5ACS, C174.
type 4AWS, C170.
type 5AWS, C171.
type 3TCS, C175.
type 4TCS, C176.
type 5TCS, C177.
type 5TWS, C179.
type 4TWS, C178.
cotton rubber-lined fire hose (couplings and gaskets), C114.
cotton waste, colored, C263.
cotton waste, white, C262.

Specifications—Continued.
United States Government master, for—Contd.
diaphragm packing, C240.
dry cells, C139.
fire-extinguishing liquid, C134.
flat glass for glazing purposes, C164.
flat interior lithopone paint, white and light tints, C111.
flax packing, C239.
friction tape, C229.
general specifications for rubber goods (methods of physical tests and chemical analysis), C232.
gloss interior lithopone paint, white and light tints, C147.
green paint, semipaste and ready mixed, C97.
grit cake soap, C130.
gypsum plaster, C205.
gypsum plaster board, C210.
gypsum wall board, C211.
hand grit soap, C132.
heavy rust-preventive compound, C200.
hectograph ribbons, C187.
helmet-shaped ice bag, C228.
hydrated lime for structural purposes, C204.
indelible marking ink for fabrics, C197.
indigo blue denim (unshrunk), C266.
indigo blue denim (shrunk), C265.
interior varnish, C117.
iron oxide and iron hydroxide paints, C93.
installation of metal flashings with bituminous built-up roofing, C180.
installation of plastic flashings with bituminous built-up roofing, C181.
lace leather, C213.
large tungsten filament incandescent electric lamps, C13.
leaded zinc oxide, dry and paste, C88.
leather belting, C148.
light weight duck (Army duck, grey), C166.
linseed oil, raw, refined, and boiled, C82.
liquid paint drier, C105.
liquid soap, C124.
liquid soap (for laundry use), C193.
low pressure spiral gland packing, C237.
medium and light rust-preventive compounds, C214.
milled toilet soap, C194.
numbered cotton duck, C136.
ocher, dry and paste, C91.
oil suction and discharge hose, C209.
olive drab paint (semipaste and ready mixed), C165.
ordinary laundry soap, C129.
outside white titanium-zinc paint (semipaste and ready-mixed), C215.
plain, inlaid, and printed linoleum, C190.
pneumatic tires, solid tires, and inner tubes, C115.
politzer bags, C222.
Portland cement, C33.
powdered soap (for laundry use), C195.
putty, C216.
quicklime for structural purposes, C201.
record and copying ink, C182.
red ink, C184.
red lead, dry and paste, C90.
rubber air pillows, C252.
rubber bandages, C219.
rubber catheters, C225.
rubber dam, C218.
rubber finger cots, C226.
rubber fountain syringe, C251.
rubber hot-water bottles, C248.
rubber ice bags, C227.
rubber insulating tape, C230.
rubber metal gasoline hose, C269.
rubber packings and gaskets (molded, sheet, and strip), C235.
rubber pillow cases, C224.
rubber ring cushions, C246.
rubber sheeting, C253.
rubber tips for crutches, C223.
rubber valves, C244.
salt water soap, C126.
scouring compounds, for floors, and soap scouring compound, C131.
soap powder, C125.
sole leather, C198.
stamp pad ink, C185.

*For more specific reference see table of contents of the publication cited.

Specifications—Continued.
United States Goverment master, for—Contd.
stomach or lavage tube, C220.
surfacing materials for bituminous built-up roofing, C158.
surgeons' rubber gloves, C217.
surgeons' rubber aprons, C247.
surgical operating pads, C245.
tent duck (special construction for bleaching or dyeing, grey), C167.
titanium pigment, dry and paste, C163.
tucks, packing, C233.
turpentine (gum spirits and wood turpentine), C86.
typewriter ribbons, C186.
upholstery leather, C212.
vitrified chinaware, C202.
volatile mineral spirits for thinning paints, C98.
water resisting red enamel, C146.
water resisting spar varnish, C103.
white cotton rags for wiping machinery (sterilized), C264.
white floating soap (for toilet use), C123.
white paint and tinted paints made on a white base, semipaste, and ready mixed, C89.
wiping cloths, C267.
wire insertion rubber packing, C234.
wire rope, C208.
wool waste, colored, C260.
wood screws, C140.
writing ink, C183.
zinc oxide, dry and paste, C87.
Specimen, design of, T275.
Specimens, electrical-insulating materials, preparation, S471.
Spectra, absorption and reflection, S45.
absorption, of arsenic, antimony, bismuth, and nitrogen, S490.
arc, of seven elements, S372.
wave lengths, S411.
argon, krypton, and xenon, S414.
krypton and xenon, S345, S414.
mixed gases, S4.
red and infra-red, of various arcs, S324, S372, S411, S421.
secondary, S5.
star, measurements of energy distribution, S438.
stellar, photographing, S318.
wave-length measurements, S312.
wave lengths, *see* Wave lengths in spectra.
yttrium, lanthanum, and cerium, S421.
Spectral center of gravity, S443.
classification and excitation of arsenic, antimony, bismuth, and nitrogen, S490.
composition of searchlight arcs, T168.
distribution of energy by Planck's equation, tables and graphs, M56.
distribution of energy to evoke the gray sensation, S417.
energy distribution of a star, S438.
energy of the carbon glow lamp, S132.
of the firefly, S132.
lines, standard, S168.
photoelectric sensitivity of silver sulphide, S344.
radiation constants, S204, S284.
of a black body, S406.
reflection of molybdenite, S325.
reflection of Munsell color standards, T167.
transmission of the atmosphere, S389.
of various substances, S325.
transmittancy of dyes, S440.
Spectrograph, photographic, S422.
quartz rock salt, S441.
Spectrographic analysis, S444.
Spectrophotoelectric sensitivity of thalofide, S380.
of proustite, S412.
Spectrophoto-electrical sensitivity, S446, S451, S456.
Spectrophotometer, pocket, S39.
Spectrophotometry, S440.
photoelectric, by null method, S349.
Spectropyrheliometer, S378.
Spectroradiometers, S279.
of quartz, fluorite, rock salt, and sylvite, S401.
Spectroradiometric transmission data, S418.
Spectroscopes, photometric attachment, S155.
Spectroscopic notes, S441.
Spectroscopy, *see* Reports, annual, of the director.
Spectrum, acetylene flame, S362.
analysis, S477.
Spectrum, acetylene flame—Continued.
helium, S302.
iron, S251, S274.
lines in polariscopic measurements, S34.
neon, S329.
gas, S251.
tubes, preparation of, S441.
visibility of radiant energy in, S475.
visible, of acetylene flame, S279.
Speed of photographic plates, S439.
Sperm candle, S227.
Sphere, integrating photometric, S447.
Ulbricht, for measuring reflection factors. S415.
Spherical aberration of thin lenses, S461.
candlepower, measurement by sphere, S441.
Spindle, mooring, T270.
Spiral gland packing, low-pressure, C237.
Spirals, inductance, S455.
Springs, bedstead, sizes, R2.
Square coils, inductance, S468.
Stability test for smokeless powder, S192.
Stabilized-platform weighing scale, T106.
Staining of fibers for photomicrography, T217.
Stainless steel, thermal expansion, S426.
Stamp-pad ink, specification for, C185.
Standard absorption bands, radiometric investigation, S168.
acidimetric, S183.
barrel law, Federal, C71, M1.
Baumé hydrometer scales, C59.
boxes, T253.
bushel, C10.
cell, S27, S70, S71, S102, M16.
Clark, S390.
voltage of, S220.
Weston, S104.
cells, preliminary specifications, S67.
cement sieves, T29.
combustion samples, C11.
cubic foot, for gas, T114.
density and volumetric tables, C19.
gage for sheet and plate iron and steel, C18.
hose couplings and fittings, C50.
kilogram, S17.
lamps, S222.
lens and prism material, S401.
measurement, C149.
meter, S17.
methods of gas testing, C48.
pound, S17.
resistance, new form, S107.
samples, C25, C40, C45.
alloy steels, C25.
bearing metals, C25.
benzoic acid, C25.
brass, C25.
bronze, C25
cement, C25.
general information, C25.
iron, C25.
ores, C25.
limestone, C25.
magnetite ore, C25.
manganese ore, C25.
naphthalene, C25.
ores, C26.
sodium oxalate, C25.
steel, C14, C25.
sugars, C25.
thermometric fixed points, C25, C66.
zinc ore, C25.
see also Reports, annual, of the director.
scale of temperature, S69.
secondary, pentane lamp as, S216.
sieves, specifications and measurements, C39.
sodium oxalate, in volumetric analysis, C40.
specifications cotton rubber-lined fire hose, C114.
incandescent lamps, C13.
transformers, C22.
spectral lines, C168.
tables for petroleum oils, C57.
test specimens of zinc bronze, T59.
turbidity, of water analysis, S367.
turpentine specification, C86.
wave lengths, S441.
wave meter of Bureau of Standards, S489.
weights and measures, S17.
of United States, history of, M64.
yard, S17.

*For more specific reference see table of contents of the publication cited.

Standardization, *see* Standardizing.
see Simplification and Specification.
of bomb calorimeters, C25.
of cement sieves, C25.
of paving brick sizes, R1.
of radio-frequency, S489.
of sizes of blackboard slate, R15.
of sizes of brass lavatory and sink traps, R21.
of sizes of builders' hardware, R18.
of sizes of chinaware, R33.
of sizes of concrete building units (block, tile, and brick,) R32.
of sizes of cotton duck, R27.
of sizes of eave troughs, conductor pipe, conductor elbows, and fittings, R29.
of sizes of hospital beds, R24.
of sizes of hot water storage tanks, R25.
of sizes of loaded paper shot shells, R31.
of sizes of milling cutters, R36.
of sizes of plow bolts, R23.
of sizes of sheet steel, R28.
of sizes of steel barrels and drums, R20.
of sizes of steel lockers, R35.
of sizes of steel reinforcing bars, R26.
of sizes of structural slate, R13.
of sizes of terne plate, R30.
Standardized method of determining solidification points, S340.
Standardizing automobile-tire fabric testing, T68.
bomb calorimeters, C11.
cement sieves, T42.
containers for foodstuffs, M43.
electrical practice in mines, C23.
gauges, S436.
potassium permanganate solution, S182.
Saybolt universal viscosimeter, T112.
sulphur boiling point, S339.
Standards, Bureau, *see* Report, annual.
capacity, S137, C4, C74.
electric, C60.
international committee, M16.
service, C56.
*federal authority regarding, M7.
flame, in photometry, S222.
gas service, C32.
hose couplings, C50, M42, M61.
inductance, S29, C74.
serpentine, S15.
low-resistance, measuring inductances, S246, C74.
magnetic, S295.
mass, design and test, C3.
measurement, C2.
mica condensers, S137.
of wave length, S478, S479.
pipe threads, M42, M61.
radiation, S227, S262.
resistance, S256.
four-terminal, S281.
mercurial, S256.
see also Reports, annual, of the director.
screw threads, M42, M61.
service, of quality and safety, C68.
weight and measure, S17.
Standing waves on wires, S491.
Stars, radiometric measurements on, S244.
spectral energy distribution, S438.
State, M55, M59.
law, model, on weights and measures, M9, M11, M13.
standard enabling municipalities to adopt zoning regulations, M54.
officials, weights and measures, M4, M20.
officials of weights and measures, conferences, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M41, M43, M48, M55, M59.
regulation of public utilities, C112.
sealer, functions, M11, M41, M48.
weights and measures laws, M20.
zoning enabling act, a standard, BH5.
Static friction, effect on indications of scales, T106.
Statically indeterminate crane, load tests, T151.
Station call letters, radio, C122.
Station rules for work on electrical equipment, C49.
license, radio, C122.
Statoscopes, T237.
Steam-turbine expansion, S167.
wheels, windage resistance, S208.
Steatite fibers, elastic properties, S7.
Steel, T267.
analysis, T6, T8, T24, T33, T118, T126, T141, T207, C14.
and concrete bond resistance, T173.
annealed eutectoid carbon, magnetic properties, S408.
arc-fused, properties of, T179.
as affected by manganese, S464.
barrels and drums, R20.
car wheels, tensile tests at high temperatures, T219.
thermal stresses in, T235.
carbon, at high temperatures, T219.
carbon, mechanical properties, T206.
cast, wheels, T150.
centrifugally cast, T192.
changes in structure upon annealing, S397.
deep etching, T156.
determination of nitrogen in, S457.
determining carbon in, T33.
enamels for, T165.
etched by ammonium persulphate, S402.
eutectoid carbon, S404.
gases in, T118, T126.
hardened and of tempered, S452.
high speed, characteristics and heat treatment, S395.
lockers, R35.
macrostructure of, T156.
magnetic and mechanical properties, S272.
manufacture, T91.
of sound ingots, T178.
mild, microstructure at high temperatures, S356.
nickel, properties of, C58.
open-hearth, cold-rolling tests of, T288.
oxygen by Ledebur method, T118.
plates containing zirconium, T207.
properties for enameling, T165.
rails from sink-head and ordinary ingots, T178.
manufacture, T38.
reinforcing bars, R26.
rifle-barrel, analyzed magnetically, S343.
rustproofing, C80.
sheet, R28.
sheet and plate, gauge, C18.
standard samples, C25.
tanks, stresses in, T243.
tempering, S396.
thermal expansion of, S433.
titanium and silicon deoxidation of, T241.
transformer, S109.
tubes, T258.
wire, R9.
effect of stress on magnetic properties, S496.
Steels, acid Bessemer, S346.
alloy, at high temperatures, T205.
containing rare elements, T207.
and irons, determining carbon content, T69.
annealed carbon, grain size, S397.
carbon monoxide and carbon dioxide content, T126.
containing vanadium, determining phosphorus in, T24.
determining chromium in, T6.
vanadium in, T6, T8.
hardened carbon, changes upon heating, S396.
low-carbon, open-hearth, T203.
nickel, critical ranges, S376.
vanadium and chromevanadium, S161.
Stefan's formula, S41.
Stellar radiometers, S244.
radiometry, S438.
spectra, photographing, S318.
temperatures, S438, S460.
thermocouple, S229.
Stellite, reflecting power, S308, S342, S379.
thermal expansion, S426.
Stem correction of thermometers, S170.
Sterilization of goggles, H2.
Stibnite, photo-electrical conduction, S398.
spectrophoto-electrical properties, S322, S398, S462.
ultra-violet reflecting power, S493.
Stitches, tests, T96.
Stomach tubes, C220.

*For more specific reference see table of contents of the publication cited.

Stone preservatives, T248.
tests, C45.
Storage batteries, S450, T149, T225, C92.
battery separators, T271.
battery testing by cadmium electrode, T146.
tanks, hot water, R25.
Stores, *see* Reports, annual, of the director.
Stowage, C77.
Straight bars, magnetic induction in, S117.
tungsten filaments, emissivity, S300.
Strain-gauge measurements, T260.
on steel tanks, T243.
test of reinforced concrete flat slab, T236.
of 150-ton floating crane, T151.
tests on columns, T263.
on tiles, T120.
on wheels, T150.
initial, T101.
Straining tests of marble, T123.
Strays, relation to radio reception, S476.
Street railway roadbeds, leakage resistance, T127.
Strength, brass, T83.
clays, T79.
compressive, of hollow tile, T120.
of rectangular spruce struts, T152.
compressive, of sand-lime brick walls, T276.
concretes, T58.
crushing, of Portland cement mortar and concrete, T5.
hollow tile walls, T238.
of brick, T251.
of columns, T263.
of electrical insulating materials, T216.
of tubes, T258.
refractory bodies, T104.
reinforced concrete beams, T2.
rope, T198.
tests of marble, T123.
wire rope, T121.
Stress, T260.
diagrams for tiles, T120.
effect on magnetic properties of steel wire, S496.
in columns, T263.
initial, produced by "burning in" manganese bronze, T84.
internal, in brass tubing, T257, T285.
modulus curves for columns, T263.
repeated reversals, on concrete beams, T182.
strain curve equation, sand-lime brick walls, T276.
strain curves of mortar in sand-lime brick walls, T276.
strain tests of paper bags, T187.
Stresses caused by cold-rolling, T163.
in slabs reinforced diagonally, T233.
initial, in wrought brasses, T82.
internal, in brass, S321.
relaxation, S358.
steel tanks, T243.
thermal, in car wheels, T209.
in steel car wheels, T235.
Striae in electrodeposited silver, S195.
optical glass, S333, S373.
Stricken bushel, C10.
Strip, cold-rolled, T288.
hot, ammeter, S206.
method, measurement of internal stress in metal tubing, T257.
Strontium, Case's photo-electric cells, S462.
critical potentials, S403.
Structural, C201.
alloy steels at high temperatures, T205.
materials, *see* Reports, annual, of the director.
slate, R13.
steel columns, T184.
Structure and related properties of metals, C113.
Structures, deformed, T270.
tiles for, T120.
Strut thermometers (aircraft), T237.
Struts, T218, T258.
spruce, compressive strength, T152.
tapered, T152.
Stucco construction, durability, T70.
hair in first coat, T70.
method of sheathing, T70.
on coated wood lath, T70.
on monolithic concrete basis, T70.
surface finish, T70.
Subject classification, radio, C138.
Subscriber, telephone, C112.
Substances, standard, for calibrating viscometers, S298.
Substitutes for tin in alloys, T109.
Substitution weighing, T208.
Sucrose and quartz dispersion ratio, S268.
double-polarization method for estimating, S375.
optical rotation of, S52.
solubility in sugar mixtures, T259.
specific rotation, S268.
standard sample, C25.
Sugar, recommended specification for quicklime, limestone, hydrated lime, and lime powder for use in the manufacture of, C207.
solutions, specific gravity by Baumé scale, T115.
Sugars, evaporation in testing, S221.
testing, S221.
Sulphate pulps in paper, T189.
Sulphation of storage battery plates, T225.
Sulphide, silver, S446.
Sulphite pulp, limestone, and quicklime for use in manufacture of, C144.
cellulose extract, T215.
Sulphite pulps in paper, T189.
Sulphocyanic acid, S54.
Sulphur boiling point, S149, S339.
determination, in rubber, T45.
dioxide, determination by thermal conductivity method, T249.
effect on red shortness of iron, T261.
in illuminating gas, T20.
in india rubber analysis, S174.
in nickel, T281.
in petroleum oils, T177.
Sulphuric acid, effect on wood, T271.
solutions, S275.
Sun, component radiations, S378.
radiation constant, S105.
Sunlight, action upon lubricating oils, S153.
Sunrise and sunset, effect on radio transmission, S476.
effect, radio waves, S353.
Superconductivity, S307.
Superheated vapor, S501.
Supply line operation, C49.
Surface resistivity of insulators, S234.
treatments for masonry, T248.
Surfaces, radiating, S51.
Surfacing materials for bituminous built-up roofing, C158.
Surgeons' rubber aprons, C247.
rubber gloves, C217.
Surgical operating pads, C245.
Survey of elevator interlocks, T202.
Susceptibility, magnetic, of brass containing iron, T221.
Switchboard operation, C49.
voltmeters and ammeters, S163.
Switchboards, H3.
Swinging, effect of reception of signals, S476.
Sylvite, refractive indices, S401.
spectroradiometers, S401.
transmission, S168.
Syringe, fountain, cloth-inserted, C250.
rubber fountain, C251.
System carbon, iron oxide; and hydrogen, equilibrium conditions, S350.
lead acetate, lead oxide, water at 25°, S232.
Systems of screw threads, M42, M49, M61.

T

Table, copper-wire, M17.
sizes in wire gages, C67.
unit displacement of commodities, C77.
Tables, calculation of inductance, S93, S169, S320, C74.
copper wire, C31.
density and volumetric, C19.
Tables for the calculation of inductance, S495.
gas calorimeter, C65.
inductance, S93, S169, S320, C74.
of equivalents, units of weight and measure, C47.
on mutual and self-inductance, S169.
standard, for petroleum oils, C57.
thermodynamic properties of ammonia, C142.
weights and measures, M1.

*For more specific reference see table of contents of the publication cited.

Tachometers (aircraft), T237.
Talbot's law, S26.
Tangent modulus and column strength, T263.
Tanks, expansion, simplified practice in, R8.
  hot water storage, R25.
  stresses in steel, T243.
Tantalum rectifiers, T265.
  radiation constant, S105.
  reflecting power, S152.
  thermoelectric properties, S120.
Tape, rubber friction, C229.
  rubber insulated, C230.
Tapes, measuring, C2.
Tar, coal, C155, C157.
Taximeters, M55, M59.
  testing, M41.
Tearing instruments, strengths, and test methods for paper, T194.
Technical methods of testing miscellaneous supplies, M15.
News Bulletin, *see* Reports, annual, of the director.
  thermodynamics, *see* Annual reports of the Director.
Technology of cotton machinery, T282.
Telemetric devices, T247.
Telephone art, development, C112.
  industry, development, C112.
  plant, C112.
  service, C112.
    standards, *see* Reports, annual, of the director.
  shunt condenser, C137.
  traffic, C112.
Telephonic transmission, S101.
Telephony, radio, S423, C112.
Telescopic objective, graphical solution for a, S461.
Temperature and luminosity, S133.
  change, effect of rate on transformations in steel, S335.
  coefficient of permeability, S245.
    quartz, S34, C44.
    resistance of copper, S147.
  copper, estimation, S121.
  effect on tensile properties of boiler plate, T219.
  formula of Weston cell, S104.
  incandescent lamps, S40.
  measurement in ceramic kilns, T40.
  measurements in Bessemer and open-hearth practice, T91.
  of the arc, S8.
  related to luminosity of black body, S270.
  rise method, T275.
  scale, S143.
  standard scale of, S69.
  thermodynamic scale, S57.
  transition of sodium sulphate, S68.
  uniformity in an electric furnace, S219.
Temperatures, dew point, of fuel-air mixtures, S500.
  finishing, of rails, T38.
  high, dilatation of glass at, S393.
  ocean, S210.
  of a radiating substance, S24.
  of stars, S438.
  planetary, S460.
    stellar, S438, S460.
Tempering of steel, structural changes accompanying, S452.
Tensile properties of alloy steels at high temperatures, T205.
  strength, electrical insulating materials, measurement, S471.
    of mortar specimens, T276.
  stress of manganese bronze exposed to corrosion, T135.
  tests, boiler plate, at high temperatures, T219.
    apparatus for, T219.
Tension, interfacial, of oils, T223.
Tent duck for bleaching and dyeing, C167.
Terminal apparatus, influence on transmission, S101.
Terminology of electric wire and cables, C37.
Terneplate, R30.
Terra-cottas, thermal expansivities of, S485.
Terrestrial magnetism, relation to radio signals, S476.
Test, evaporation, for mineral oils, T13.
  for neutrality, S178.
  Hartmann, for lenses, S311.
  laboratory wearing, on different depths in a hide, T166.
  methods for developing specifications for paper bags, T187.
  methods for duck, C136.
  of hollow tile and concrete floor slab, T220.
  specimens of zinc bronze, T59.
  stability, for smokeless powder, S192.
  steam, of Portland cement, T47.
  titanium pigment, C163.
  see also Testing, and tests.
Testing, S507, M55, M59.
  apparatus for brick, T251.
  automobile-tire fabric, T68.
  ball clays, T227.
  barometers, C46.
  bomb calorimeters, C11.
  bond resistance between concrete and steel, T173.
  *capacity measures, M11.
  centrifugally cast steel, T192.
  chemical glassware, T107.
  clay refractories, T7.
  clinical thermometers, S13, C5.
  commercial marbles, T123.
  current transformers, S309.
  damp-proofing and waterproofing materials for concrete, T3.
  dry cells, C79.
    *gas meters, M11.
  electric condensers, C36.
  electric, magnetic, and photometric standards, C6.
  electrical insulating materials, S471.
  flexible gas tubing, T133.
  floating crane 150-ton, T151.
  for hydrogen sulphide in gas, T41.
    "oiliness," T204.
  gas, standard methods, C48.
  glass volumetric apparatus, S92, C9.
  hollow building tiles, T120.
  hydrometers, C16.
  inks, C95.
  instrument transformers, S233.
  intermittent, of dry cells and batteries, T171.
  laboratory, electric, control system, S291.
  large bridge columns, T101.
  leather, T153.
  life of incadescent lamps, S265.
  light aluminum casting alloys, T139.
  magnetic, S78, S108, C17.
    compasses, S382.
    of straight rods, S361.
  manila rope, T198.
  mass standards, C3.
  materials, C45, M62.
  measuring apparatus, C2.
  metal capacity measures, C4.
  metallographic, C42.
  meter provers, T114
  methods, T270, T275.
  methods of fatigue, T275.
  miscellaneous supplies, M15.
  motor-truck wheels, T150.
  of columns, T263.
  of dry cells, C79.
  of radio receiving sets, methods of, T256.
  optical instruments, C27.
  orient coal, T134.
  paper, T194, C107.
  physical, of cotton yarns, T19.
  platform scales, M10.
  polariscopic apparatus, C12.
  porcelain laboratory ware, T105.
  potential transformers, S217.
  potentiometers, S223.
  printing inks, C53.
  properties of Portland cement mortars and concretes, T3.
  pyrometer, C25.
  pyrometers, C7.
  reinforced concrete beams, T2.
    columns, T122.

*For more specific reference see table of contents of the publication cited.

Testing—Continued.
resistance of oil to emulsification, T86.
rubber goods, C38.
sieves, C39.
silver nitrate, S201.
silica refractories, T116.
soap, specifications and methods, C62.
standards of capacity, C4.
of mass, C3.
stitches and seams, T96.
storage batteries by cadmium electrode, T146.
sugars, S221.
sugars, effect of evaporation, S221.
*taximeters, M41.
textile materials, C41.
thermometers, C8.
timepieces, C51.
transformer steel, S109.
transparency of paper and tracing cloth, C63.
voltmeter, S79.
water meters, M11.
weights and measures, M1.
see Weights and measures conferences.
see also Test, Tests, and specifications of devices and material.
Tests, compressions, T218.
fire, building columns, T184.
for chinaware, methods, C202.
magnetic, electric, and photometric, C6.
of brick, T251.
of stellar radiometers, S438.
of tubes, T258.
of welded and riveted tanks, T243.
precision, of large capacity scales, T199.
pressure and pouring, of concrete, T175.
qualitative, for gum arabic, T67.
short-time fatigue, T275.
summary, *see* Reports, annual, of the director.
textiles, T264.
see also Test, and Testing.
Textbooks, radio, C122.
Textile conference, second annual, M19.
heat-insulating value, T269.
heat-transmission apparatus, T269.
materials, testing and properties, C41.
specification, T264, C136, C167.
test methods, T264.
tests, C45.
Textiles, blankets, T266.
heat insulation, T266.
see Reports, annual, of the director.
Thallium, S456.
photo-electrical properties of halide salts of, S456.
Thalofide, spectrophotoelectric sensitivity, S380.
Theory, atomic, S386.
coupled circuits, S112.
galvanometer, S273.
geometrical, of radiating surfaces, S51.
Hampson liquefier, S123.
least squares, S304.
potentiometer, S223.
Thermal ammeters, S206.
analysis, S332.
by modified Rosenhain furnace, S348.
inverse-rate method, S336.
method, S213, S348.
nickel steels, S376.
recording chronograph for inverse-rate method of, T230.
changes upon heating hardened carbon steels, S396.
characteristics of chromium steel, S335.
dilation of glass at high temperatures, S393.
expansion, aluminum and its alloys, S497.
American petroleum oils, T77.
brass, S321.
copper, S410.
electrical insulating materials, S471.
ethyl alcohol, S197.
insulating materials, S352.
linseed oil and turpentine, T9.
marble, T123.
measurements, C2, S471.
molybdenum, S332, S488.
nickel, monel metal, stellite, stainless steel, and aluminum, S426.
of clays and glazes, S485.
of steels, S433.
Thermal—Continued.
expansivity of electrical insulating materials, T216.
see Reports, annual, of the director.
leakage control, S503.
metallurgy, *see* Reports, annual, of the Director.
properties, S501.
radiation from a black body, S406.
verification of laws, S406.
radiophonic signaling, S398.
stresses in chilled iron car wheels, T209.
in steel car wheels, T235.
Thermionic rectifiers, T265.
tube, emission, S317.
see also Electron tube.
Thermocouple ammeters, S206.
Thermocouples, S244.
cold-junction corrections, S202.
sensitivity tests of stellar, S188, S229, S244, S438, S460.
Thermodynamic properties, S501.
of ammonia, tables and Mollier chart of, C142.
of concentration cells, S165.
scale of temperature, S57.
temperature of ice point, S57.
Thermoelectric measurement of critical ranges of pure iron, S296.
power of molybdenum copper, S152.
properties of tantalum and tungsten, S120.
Thermoelements, protected, S276.
Thermometer comparator, S69.
gas, constant-pressure, S57.
Thermometers (aircraft), T237.
calorimetric resistance, S200.
capillary, S170.
clinical, comparator, S13.
testing, C5, S13.
emergent-stem correction, T49.
high temperature, S32.
mercurial, stem correction, S170.
platinum resistance, S407.
resistance, S68, S294.
testing, C8.
Thermometric fixed points, C25, C66.
lag, S185.
Thermometry, platinum resistance, S124.
resistance, S241.
apparatus, S288.
see also Reports, annual, of the director.
Thermopile, S85.
absolute, S261.
Thermopiles, bismuth-silver, S229.
vacuum, S188, S413.
Thermoregulation, S503.
Thickness, T226.
of paper, T226.
Thin lenses, spherical aberration of, S461.
Thinner, composite, specification, C102.
volatile, in oil varnish, T76.
Thinning paints, volatile mineral spirits for, C98.
Thomson bridge, S181, S225.
galvanometer, S282.
Tile, C151.
and concrete floor slab test, T220.
cement, in alkali soils, T44, T95.
hollow building, simplified practice in, R12.
clay and concrete slabs, tests of, C261.
slab, loading test, T236.
walls, strength of, T23?
Tiles, T120.
absorption tests, T120.
building, tests, T120.
compression tests, T120.
Time, effect on strains in concrete, T236.
factor in vitrification of clays, T17.
for cooking rags in paper manufacture, C96.
measurement of short-time intervals, S470.
measurements, C51, C55.
of building, sand-lime brick walls, T276.
see also Reports, annual, of the director.
Timepieces, tests, C51.
Tin, arc spectrum, S411.
boiler plugs, T53.
coating on sheet copper, T90.
conservation in alloys, T109.
deterioration of, T53.
Tin, standard for melting point, C25.
standard samples, C66.
substitutes for, in alloys, T109

*For more specific reference see table of contents of the publication cited.

Tips, rubber, crutch, C223.
Tire, automobile, losses in, T213.
fabric testing, T68.
Tires, T240, T283, 294.
effect of pressure and construction, T294.
effect on fuel consumption, T283.
foreign specifications, T61.
rolling resistance of, T294.
rubber, specifications, C115.
Titanium, arc spectrum, S372.
as a deoxidizer of rail steel, T241.
Titanium pigment, comments on, T274.
pigment specification, C163.
Zinc paint, semipaste and ready mixed, C215.
Tolerance in duck measurements, C136.
textiles, T264.
weighing and measuring devices, C61, M55, M59.
weights and measures, C61, M55, M59.
testing, M1.
Tolerances, M55, M59.
committee report, M11, M12, M43, M48, M55, M59.
for hose couplings, C50, M42, M61.
mass standards, C3.
screw threads, M42, M61.
Toll line telephone, C112.
Toluol recovery, T117.
Ton of coal, proposed weight, M51.
Tools, forged, simplified practice in, R17.
Toroidal coil, self-inductance, S74.
Torque of electrical instruments, S145.
Tracing cloth, transparency, C63.
Track leakage, electric railway, T75.
*scales, M13, M14, M41.
*design, M9.
Trailing wire antenna, airplane, S341.
Transformations in alloy steel, S335.
Transformer, amplifier, C141.
coupling, S449.
current, S164.
oils, mineral, T13.
steel, S109.
Transformers, current, S233, S309.
formulas, S211.
instrument, S130, S164, S211, S217, S309, C20.
testing, S233.
iron losses in, S88.
leakage reactance, S455, S468.
potential, S129, S217.
ratio and phase relation, S116.
standard specifications, C22.
testing, S217, S233, S309.
voltage, S211, S217, S233.
Transmission, S506.
and reception, radio, with antenna and coil aerials, S354.
data in spectrum, S418.
on standard optical materials, S401.
factors, absolute measurement, S405.
measured by Ulbricht sphere, S415.
formulas, radio, S159, S226, S354.
light, tracing cloth, C63.
optical, H2.
phenomena, radio, S353.
radiotelegraphic, S226.
spectral of the atmosphere, S389.
of various substances, S325.
telephonic, S101.
visible and ultra-violet, of colored glasses, T148.
Transmissive, spectral, properties of dyes, S440.
Transmittancy, spectral, of dyes, S440.
Transmitter, electron tube, of modulated waves, S381.
Transparency of paper and tracing cloth, C63.
Transverse strength, T258.
tests of brick, T111, T251.
Treatment, heat, of duralumin, S347.
high-speed steel, S395.
Tree, effect on antenna resistance, S269.
Triangular coils, inductance, S468.
Triode, *see* Electron tubes.
Trisodium phosphate, use in reclamation of gasoline, T280.
Trolley wires, H3.
Tube, colon, rubber, C221.
modulator, in radio telephone sets, S423.
Tubes, T258.
Lavage, C220.
rubber, C220.
spectrum, S441.
Tubing, brass, internal stress in, T257, T285.
gas, flexible, T133.
Tubular electrodynamometer, S184.
Tucks packing, C233.
Tumblers, flint-lime glass, specification, C119.
Tuned-plate coupling, S449.
Tungar rectifier tube, S450.
Tungsten, arc spectrum, S372.
comparison lamp, S115.
filament lamps, equations, S238.
filaments, straight and helical, S300.
lamps compared with glass screens, S277.
vacuum, S253.
radiation constant, S105.
reflecting power, S152, S308.
selective radiation, S131.
thermoelectric properties, S120.
Tuning fork for radio-frequency standardization, S489.
Turbid media, optics, S367.
properties, S367.
Turbidimeter, Bureau of Standards design, S367.
Turbidity standard of water analysis, S367.
Turn indicators, T237.
Turpentine, comments on, T274.
density and thermal expansion, T9.
specification, C86.
specifications, C86.
Twist of cotton yarn, T278.
of 7's yarn, T278.
Two-circuit electrodynamometer, S48.
Typewriter ribbons, C95.
specification for, C186.

U

Ubbelohde viscosimeter, T125.
Ulbricht intergrating sphere, theory and construction, S447.
sphere for measuring reflection factors, S415.
Ultraradio frequencies, determination of, S491.
Ultraradio frequency directive transmission, S469.
Ultraudion, *see* Electron tube.
Ultra-violet light, H2.
exclusion from buildings, S378.
radiation from quartz mercury vapor lamps, S330.
rays, protecting eyes from, T93.
reflecting power, pyrites, stibnite, molybdenite, graphite, galena, duralumin, S493.
transmission of eye-protective glasses, T119.
of colored glasses, T148.
Unbleached cheesecloth, C258.
duck, C167.
sulphite and sulphate pulps in paper, T189.
Underwear, laundering, T273.
Underground cables, C49.
telephone cables, C112.
Uniformity of bars for magnetic standards, S295.
of temperature in an electric furnace, S219.
Uniformly heated enclosure, S204, S262, S270, S284, S305, S357. *See also* Black body.
Unit displacement of commodities, C77.
type radio receiving set, C133.
Units, area, C2.
candlepower, S50.
electrical, international, S3, C29, C60.
committee, M16.
and magnetic, international, S292.
electromagnetic and electrostatic, S65, S66.
fundamental electrical, for international adoption, S102.
light, international, C15.
length, C2.
luminous intensity, S50.
photometric, S141.
weight and measure, C47.
Universal-wound inductance coils, S455.
Unshrunk blue denim, C266.
brown denim, C259.
Unsound cement affected by Cal, T174.
Unsurfaced built-up roofing, asphalt for, C168.
Upholstery leather, C212.
Uranium, arc spectrum, S372.
U. S. specification for Portland cement, C33.
standard Baumé hydrometer scales, C59.
tables for petroleum oils, C57.
weights and measures laws, M20.
Uses of gypsum, C108.
lime, C30.
Utilization of beet sugar waste water, C145.

*For more specific reference see table of contents of the publication cited.

V

Vacuum bolometers, S188, S204.
  fused alloys of iron, S453.
  galvanometers, S204, S229, S282.
  jacketed calorimeters, S231.
  radiomicrometers, S46, S188.
  thermopile mounting, S282.
  thermopiles, S188, S413.
  tube, *see* Electron tubes.
    three-electrode, input impedence, S351.
  tungsten lamps, S253.
Value of Bessel's functions, S100.
  international volt, C29.
  the Faraday, S218.
Valve, *see* Electron tubes.
Valves, electrolytic, T265.
  rubber, C244.
Vanadium, analyzed steels, C25.
  arc spectrum, S372.
  determined in steels, T8.
  separation from chromium in steels, T6.
  steels, S161.
Vapor, ammonia, S501.
  cadmium, S317.
    arc lamp, S371.
  caesium, low-voltage arcs, S386.
  lamp, quartz mercury, component radiation, S378.
  pressure of ammonia, S369.
  specific volume of saturated ammonia, S467.
Vaporization of ammonia, latent heat, S315.
  of gasoline, *see* Dew points, S500.
Vapors of lead and calcium, electrons in, S368.
Variable, independent, observations at equal intervals, S388.
  inductor, S290.
  periodic, S90.
  self and mutual inductor, S290.
Variance of measuring instruments, S328.
Variation in density of photographic plates, S409.
  of resistances with humidity, S73.
Variocoupler, S290.
Variometer, S290.
  see also Inductor.
Varnish, asphalt, specification, C104.
  application, T274.
  determining oil and resin in, T65.
  interior, comments on, T274.
  interior, specification, C117.
  materials, C69.
    linseed oil, C82.
    mineral spirits, C98.
    turpentine, C86.
  oil, volatile thinner, T76.
  shellac, T232.
  spar, comments on, T274.
  spar, specification, C103.
Varnishes and paints, L1.
  see Reports, annual, of the director.
Vegetation, effect on signal intensity, S476.
Vehicle, composite, comments on, T274.
  tanks, M55, M59.
  type batteries, operation and care, C92.
Velocity of light, S65.
  of projectiles, T255.
Verilite, thermal expansion, S497.
Veritas firing rings, T40.
Vibrating rectifiers, T265.
Vibration electrometer, S239.
  galvanometer, S134, S370.
    in measuring inductance, S14.
Viscometer, Redwood, T210.
Viscometers, calibrating, S298.
Viscosimeters, short-tube, T100.
Viscosimeter, conversion tables, T210.
  Saybolt, T112.
Viscosity, absolute, by short-tube viscosimeters, T100.
  gasoline, T125.
  or plasticity of glass, S358.
  porcelain bodies, T30, T50.
  Saybolt, of blends, T164.
  water, sucrose, and ethyl alcohol solutions, S298.
Visibility of radiant energy, S475.
  of radiation, S154.
Visual use of objectives, T217.
Visible spectrum, acetylene flame, S279.
  transmission, colored glasses, T148.
    eye-protective glasses, T119.
Visiting committee, M63.
Vitrification of clays, T17, T79.
Voice modulation, radiotelephony, S423.
Volatile mineral spirits for thinning paints, C98.
  thinner in oil varnish, T76.
Volatilization of platinum, S280.
Volt, international, value, C29.
  scale for watts-per-candle meter, S113.
Voltage, dry cells, S364.
  induced, in high-tension magneto, S424.
  measurement, S172.
  oscillations in automobile battery circuits, T186.
  transformer, S129.
Voltameter, silver, S2, S27, S102, S171, S194, S195, S201, S220, S240, S283, S285, M16.
  deposits, inclusions, S271.
Voltameters, silver and iodine, S218.
Voltmeter testing, S79.
Voltmeters, C20.
  switchboard, S163.
Volume changes in burning silica refractories, T116.
  effect in silver voltameter, S283.
  of oil at 60° F., C57.
  of petroleum oils at 60° F., C154.
  resistivity of insulators, S234.
  resistivity, measurement, S471.
  specific, of liquid ammonia, S420.
  specific, of saturated ammonia vapor, S467.
Volumetric analysis, sodium oxalate standard, C40.
  apparatus, glass, tests, S92, C9.
  tables, standard, C19.
Vulcanized rubber goods, T64.

W

Wall board, gypsum, C211.
  construction, minimum requirements for masonry, BH6.
Wallettes, compressive strength of sand-lime brick, T276.
Wall plaster, C151.
  colored, T181.
Walls, compressive strength of sand-lime brick, T276.
  hollow tile, strength of, T238.
  in a photometric laboratory, S20.
War work of the Bureau of Standards, M46.
Ware, enameled cast-iron, T142.
  platinum, S254.
  porcelain laboratory, T105.
Warping of marble, T 123.
Waste, asphalt, in industry, R4.
  colored cotton, C263.
  reduction, T253.
  silk, T268.
  white cotton, C262.
  wool, colored, C260.
Watches, C51.
Water analysis, turbidity standard, S367.
  determination of, S267.
  for boiler and technical use, tests, C45.
  measurements, C55.
  *meters, testing, M11.
  of crystallization, S168.
  purification of, lime for use in, C231.
  specific heat, S247.
  soluble (press cloth), T231.
  solubility of dextrose in, S437.
  vapor detector, T242.
Waterproofing, asphalt for, C160.
  asphalt primer for, C162.
  asphalt saturated rag felt for, C161.
  coal tar for, C155.
  coal-tar saturated rag felt for, C156.
  concrete to prevent electrolysis, T18.
  materials for concrete, T3.
Watt-hour meter method of testing transformers, S233.
  meters, C20.
  direct-current, S207.
Wattmeter methods of measuring power, S18.
Wattmeters, S48, S184, C20.
  integrating induction, S21.

*For more specific reference see table of contents of the publication cited.

Watts-per-candle meter, S113.
Wave detector, S22.
Wave form analysis, S203.
and losses in transformers, S88.
magnetic hysteresis, S106.
influence on rate of wattmeters, S21.
of magnetic flux, S87.
front, radio, variation in direction, S353.
length, effect of antenna resistance, C269, C74.
effective, of transmission of pyrometer color screens, S260.
electromagnetic waves, S235.
lengths in spectra of seven elements, S372.
aluminum, S411.
antimony, S411.
argon, krypton, and xenon, S414.
barium, S312.
bismuth, S411.
cadmium, S411, S479.
caesium, S312, S386.
calcium, S312.
cerium, S421.
chromium, S372.
cobalt, S324.
copper, S312.
dyprosium, S466.
from 5600A to 9600A, S312.
gadolinium, S466.
gold, S411.
helium, S302.
iron, S251, S274, S324, S478, S479,
krypton, S345, S414.
lantahnum, S421.
lead, S411.
lithium, S312.
magnesium, S312.
manganese, S372.
mercury, S411.
molybdenum, S372.
neodymium, S442.
neon, S142, S179, S251, S329.
neon spectrum, S329.
nickel, S324.
potassium, S312.
rubidium, S312.
samarium, S442
silver, S411.
sodium, S312.
strontium, S312.
tin, S411.
titanium, S372.
tungsten, S372.
twenty elements, S312.
uranium, S372.
vanadium, S372.
xenon, S345, S414.
yttrium, S421.
zinc, S411.
interference measurements, S251.
measurement, S74.
measurements in arc spectra, S324, S411.
natural, of inductance coils, S326.
relation to fading, S476.
relative, S142, S179, S251, S274, S302, S329, S414.
transmission phenomena, S476.
Wave meter standardization, S489.
with improved type of resonance indicator, S502.
Waves, alternating-current, S203.
analysis of emf, S119, S203.
damping, in mercury, S289.
detector for electrical, S36.
electrical, at transition point, S114.
electromagnetic, direction of propagation, S353.
emf, S119.
modulated, electron tube transmitter of, S381.
standing, on wires, S491.
Wear of sole leather, T138, T147.
resistance at different depths in a hide, T166.
tests for leather, T215.
Wearing qualities of pima and ordinary cotton, T277.
Weather, effect on radio transmission, S476.
Weaving of cartridge-bag waste silk, T268.
Weighing, by substitution, T208.
scale with stabilized-platform, T106.
Weight, atomic, bromine, S193.
chlorine, S81.
hydrogen, S77.
of tiles, T120.
per gallon of petroleum oils, C57.
raw and clean wools, T57.
*standardization of bread, M43, M48.
units, C47.
Weights, C3, C61, M55, M59.
and measures, C55, M59.
apparatus in industrial plants, M14.
conferences, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M41, M43, M48, M51, M55, M59.
creamery, prescription and jewelers, M12.
equivalents, M1, C47.
*Federal regulation, M11, M13, M41.
history, S17.
history of standards of United States, M64.
household commodities, M39, M45, C55.
*Latin American countries, M41.
laws of the United States, M20.
see also Reports, annual, of the director.
*metric system, C47, M2, M3, M12, M14, M21, M41.
*model State law, M9, M11, M13.
officials, manual for, H1, M1.
*organization of foreign departments, M5.
*Philippine Islands, M13.
*Porto Rico, M12, M55, M59.
*report of Bureau of Standards investigation, M9.
*committee on specifications and tolerances, M11, M12, M43, M48, M55, M59.
for shipment, C77.
per bushel of various commodities, C10, M11.
per gallon of petroleum oils, C154.
specifications and tolerances, M55, M59, M61.
Weinstein's formula, S41.
Welded tanks, stresses in, T243.
Welding, acetylene, H2.
blowpipes, oxyacetylene, T200.
bronze, T84.
electric, H2.
electric-arc, of steel, T179.
internal stresses resulting from, T84.
Welsbach mantle, selective radiation, S156.
Weston standard cell, S27, S67, S70, S71.
temperature formula, S104.
Wheatstone bridge, S481.
for resistance thermometry, S241.
bridges, S288.
Wheels, foreign specifications, T61.
motor-truck, T150.
steam-turbine, windage resistance, S208.
White cast iron, graphitized upon annealing, T129.
cotton rags for wiping machinery, C264.
cotton waste, C262.
lead, basic carbonate, specification, C84.
comments on, T274.
sulphate, specification, C85.
light from the mercury arc and its complementary, S128.
physical standard of, S417.
metal-bearing alloys, T188.
paint, specifications, C89.
walls in a photometric laboratory, S20.
Whiting, C152.
Wien's displacement law, S180.
Winchester bushel, C10.
Wind drift indicator for aerial navigators, S480.
forces on airship, T270.
Windage resistance of steam-turbine wheels, S208.
Window glass, C164.
Wiping cloths, C267.
cheesecloth, C255.
rags, colored, cotton, C261.
white cotton, C264.
Wire, copper, tables, C31.
electric, terminology, C37.
gages, C67.
table of sizes, C67.
glass, C164.
insertion rubber packing, C234.
rope, C208.
on sheaves, T229.
properties, T121.

*For more specific reference see table of contents of the publication cited.

Wire—Continued.
sizes, C67.
steel, effect of stress on magnetic properties, S496.
Wires for rope, T121.
properties at high frequencies, S169, S374, S430, C74.
skin effect, S374.
stranded, use at high frequencies, C74.
Wiring rules, H3.
Wolf-proof fence, R9.
Wood columns, T184.
effect of sulphuric acid, T271.
fibered plaster, C205.
*method of sale, M41, M45.
screws, Government specification, C140, M61.
struts, T152.
Wool fabrics, laundering, T273.
fleece, scouring, T273.
tops, scouring, T273.
waste, colored, C260.
Wools, clean and raw, T57.
Work of Bureau of Standards, M18.
Bureau of Standards, during the war, M46.
Workability of clay, *see* Plasticity, T234.
Woven-wire fence, R9.
Writing ink, specification for, C183.
Wrought iron, S402.
crystallinity as shown by nick-bend test, T252.
microstructure, T97.
"nick-bend" clause in specifications, T252.
phosphorus in, T97.
structure and mechanical properties, T252.
manganese bronze exposed to corrosion under tensile stress, T135.

X

X-ray measurements, *see* Reports, annual, of the director.
X rays, soft, S425.
Xenon spectrum, S414.
wave lengths in, S345.

Y

Yarn for mail-bag duck, T278.
physical properties, T278.
Yarns, cotton, physical testing, T19.
Yellow, factors which determine saturation, T92.
Yttrium, arc spectrum, S421.

Z

Zinc, arc spectrum, S411.
bronze test specimens, T59.
critical potentials, S403.
cyanide plating solutions, T195.
oxide, comments on, T274.
oxide, specifications, C87.
plating iron and steel, C80.
reflecting power, S379.
standard samples, C66.
Zirconium in steel plates, T207.
Zone, equisignal, as aid to navigation, S480.
Zoning enabling act, a standard State, BH5.
primer, a, BH3.
State acts governing, M54.
what it is, BH3.